

POLLEN FLORA OF PAKISTAN -XLVIII. UMBELLIFERAE

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Abstract

Pollen morphology of 50 species representing 27 genera of the family Umbelliferae from Pakistan has been examined by light and scanning electron microscope. Umbelliferae is a stenopalynous family. Pollen grains usually radially symmetrical, isopolar, prolate to per-prolate, tricolporate, colpi generally with costae, colpal membrane psilate to sparsely or densely granulated, ora la-longate, sexine as thick as nexine, or slightly thicker or thinner than nexine. Tectal surface commonly striate-rugulate or rugulate-striate rarely simply striate. On the basis of exine pattern 3 distinct pollen types are recognized viz., *Bupleurum gillessii*-type, *Pleurospermum hookeri*-type, *Trachyspermum ammi*-type.

Introduction

Umbelliferae, a family of about 300 genera and 3000 species is cosmopolitan in distribution, chiefly in north temperate regions (Willis, 1973; Mabberley, 1978). In Pakistan it is represented by 56 genera and 167 species (Nasir, 1972). Aromatic herbs with hollow stems, leaves compound with sheathing bases; inflorescence umbellate, flowers 5-merous, often yellow or white; stamens 5 merous, ovary 2-carpellate, binocular, inferior, fruit schizocarp.

The family is of considerable economic importance for food, flavoring and ornamental plants. Umbelliferae also has some poisonous plants. Seeds of Umbelliferae are of importance because of their essential oils. Of this, caraway seeds (*Carum carvi*) is used in bread, Dill (*Anethum graveolens*) is use in flavoring dill pickles. Pollen morphology of various members of the family Umbelliferae has been studied by different workers from time to time. Erdtman (1952) studied pollen morphology of the family Umbelliferae. Ting (1961) examined pollen of some American species of family Umbelliferae. Ting *et al.*, (1964) examined pollen morphology of the subfamily Hydrocotyloideae: Umbelliferae. Pollen morphology of North European Flora of the family Umbelliferae has been examined by Punt (1984). However, the most comprehensive study on pollen morphology of family Umbelliferae is that of Cerceau-Larrival (1961, 1971, 1981). Pollen morphology of the family has also been studied by Erdtman *et al.*, (1961), Visset (1972), Nilsson *et al.*, (1977), Moore & Webb (1978) and Nigaud (1977, 1980).

No information is available on the pollen morphology of various species of Umbelliferae found in Pakistan. In the present studies an attempt has been made to provide a complete information on pollen morphology of the family Umbelliferae comprising of 27 genera and 50 species from Pakistan.

Materials and Methods

Pollen samples were obtained from herbarium specimens housed in Karachi University Herbarium (KUH) or from fresh specimens collected from the field. The list

of voucher specimens is deposited in KUH. The pollen grains were prepared for light (LM) and scanning microscopy (SEM) by the standard method, described by Erdtman (1952). For light microscopy, the pollen grains were mounted in unstained glycerin jelly and observations were made with a Nikon Type-2 microscope, under (E40, 0.65) and oil immersion (E100, 1.25), using 10 x eyepiece. For SEM studies, pollen grains suspended in a drop of water were directly transferred with a fine pipette to a metallic stub using double sided cellotape and coated with gold in a sputtering chamber (Ion sputter JFC-1100). Coating was restricted to 150A. The S.E.M examination was carried out on a Jeol microscope JSM-T200. The measurements are based on 15-20 readings from each specimen. Polar length, equatorial diameter, colpi length and exine thickness were measured (Table 1-3).

The terminology used is in accordance with Erdtman (1952); Faegri & Iversen (1964); Kremp (1965) and Walker & Doyle (1976).

Observations

General pollen characters of the family Umbelliferae

Pollen grains usually radially symmetrical, isopolar, prolate to per-prolate. Generally tri- colporate (rarely 4-colporate porate), colpi with costae, colpal membrane psilate to sparsely or densely granulated, ora la-longate, sexine as thick as nexine, or slightly thicker or thinner than nexine. Tectal surface commonly striate-rugulate or rugulate-striate or simple striate. On the basis of exine pattern, 3 distinct pollen types are recognized viz., *Bupleurum gilessii*-type, *Pleurospermum hookeri*-type and *Trachyspermum ammi*-type.

Key to the pollen types

- 1 + Tectum striate-rugulate or simply striate 2
 - Rugulate-striate *Pleurospermu hookeri*-type
- 2 + Tectum striate *Trachyspermum ammi*-type
 - Tectum striate to rugulate *Bupleurum gilessii*-type

I. *Bupleurum gilessii* -type (Fig. 1A-E; Fig. 2A-E)

Pollen class: 3-colporate, zonoaperturate

P/E ratio: 0.87-0.93

Aperture: Ectoapertue-colpus not sunken small margin irregular, end acute
 Endoaperture: circular.

Exine: Sexine as thick as nexine.

Ornamentation: Tectum striate-rugulate

Outline: Equatorial view oblong, polar view rounded trilobed.

Measurements: Polar axis (P) 17.5 (27.41 ± 0.4) 38.5 µm, Equatorial diameter E 10.70 (17.6 ± 0.49) 25 µm, and colpus length 10.4 (17.4 ± 0.57) 25.9 µm long. Colpal membrane granulated. Exine 1.0 (3.5 ± 0.06) 6.1 µm thick.

Table 1. General pollen characters of species found in the pollen type *Bupleurum gilestii*.

Name of Species	Shape	Polar length of pollen in μm (P)	Equatorial diameter in μm (E)	Colpus length in μm	Apocolpium	Mesocolpium	Exine thickness in μm
<i>Trachyspermum steuartii</i> (Dunn) Haf. Lamond & Rochi	Pr.	22.7 (24.4 \pm 0.50) 25.5	11.0 (11.9 \pm 0.14) 12.5	15.0 (11.9 \pm 0.11) 12.5		5.25 (6.37 \pm 0.5) 7.5	1.25 (2.13 \pm 0.16) 3.75
<i>Oenanthe javanica</i> (Blume) DC.	Pr.	28.0 (21.85 \pm 0.29) 33.0	12.5 (27.12 \pm 0.55) 26.15	15.0 (23.33 \pm 0.5) 25.0	25.0	c.10	2.25 (2.35 \pm 0.09) 2.75
<i>Bupleurum gilestii</i> Wolff.	Pr.	22.0 (23.9 \pm 0.37) 25.2	15 (17.8 \pm 0.25) 20.1	17.5 (19.42 \pm 0.314) 20.1	1.75 (2.33 \pm 0.38) 2.75	12.75 (14.41 \pm 6.3) 15.25	c. 1.25
<i>Bupleurum tenue</i> Buch Ham. ex Don.	Pr.	20.1 (22.58 \pm 0.39) 25.0	11.25 (11.84 \pm 0.15) 13.75	15.25 (18.14 \pm 0.39) 20.25	c. 2.5	c. 8.75	c. 2.25
<i>B. nigrescens</i> E. Nasir	Pr.	22.5 (23.77 \pm 0.2) 24.5	13.75 (14.66 \pm 0.2) 17.5	17.7 (20.27 \pm 0.29) 21.25	2.5.0	12.75	2.75
<i>B. exaltatum</i> M. Bieh.	Pr.	21.25 (23.13 \pm 0.23) 25.25	13.75 (16.34 \pm 0.3) 20.0	17.5 (19.01 \pm 0.26) 20.0	1.25 (1.75 \pm 0.28) 2.75	12.5 (14.37 \pm 0.6) 15.0	1.25 (1.6 \pm 0.2) 2.0
<i>B. linearifolium</i> DC.	Pr.	21.25 (23.80 \pm 0.33) 27.25	12.5 (14.02 \pm 0.23) 15.0	17.5 (19.28 \pm 0.31) 22.5	2.5 (2.58 \pm 0.88) 2.75	10.0 (10.63 \pm 0.30) 10.25	2.5
<i>B. falcatum</i> L.	Pr.	17.5 (21.38 \pm 0.40) 24.75	13.75 (14.58 \pm 0.76) 17.2	15.0 (17.87 \pm 0.31) 20.1	2.5 (2.6 \pm 0.06) 2.75	10.0 (11.04 \pm 0.5) 12.5	10.0 (11.04 \pm 0.5) 12.5
<i>B. marginatum</i> Wall. ex. DC.	Pr.	17.75 (21.44 \pm 0.28) 22.75	11.25 (13.40 \pm 1.1) 15.0	15.25 (17.47 \pm 0.15) 18.75	1.25 (1.58 \pm 0.91) 2.25	11.25 (11.35 \pm 0.06) 11.7	1.25 (1.46 \pm 0.08) 1.75
<i>Pimpinella puberula</i> (DC.) Boiss.	Pr.	30.2 (31.87 \pm 0.32) 33.75	15.0 (16.75 \pm 0.31) 17.5	20.0 (22.5 \pm 0.80) 27.5	2.5 (2.5 \pm 0.05) 2.75	7.5 (9.05 \pm 0.58) 10.0	2.0 (3.05 \pm 1.05) 7.25
<i>Pimpinella diversifolia</i> DC.	Pr.	25.0 (21.39 \pm 0.40) 31.25	15.0 (16.72 \pm 0.31) 18.6	17.75 (21.05 \pm 0.37) 25.0	7.5 (10 \pm 2.52) 12.5	2.25	2.25 (3.62 \pm 1.3) 5.0

Table 1. (Cont'd.)

Name of Species	Shape	Polar length of pollen in μm (P)	Equatorial diameter in μm (E)	Colpus length in μm	Apocolpium	Mesocolpium	Exine thickness in μm
<i>Pimpinell stewardii</i> (Durm) E. Nasir	Per-Pr	25.25 (29.48 \pm 0.63) 37.5	10.0 (13.0 \pm 0.3) 17.25	10 (19.42 \pm 0.936) 27.5	c. 7.5	2.5	2.0 (2.20 \pm 0.04) 2.25
<i>Chaerophyllum reflexum</i> Lindl.	Per-Pr	25.0 (25.85 \pm 0.40) 26.0	10.0 (10.10 \pm 0.15) 11.5	10.0 (13.46 \pm 0.85) 15.2	c. 7.5	2.5	1.25 (1.67 \pm 0.12) 2.75
<i>C. villosum</i> Wall ex DC.	Pr.	29.75 (32.2 \pm 0.2) 34.75	14.0 (16.15 \pm 0.4) 22.05	25.0 (25.95 \pm 0.36) 28.75	7.75 (10.91 \pm 0.97) 1.5	2.5 (3.5 \pm 0.54) 5.0	2.75 (2.81 \pm 0.06) 3.0
<i>Psammogeton canescens</i> (DC.) Vatke	Per-Pr	27.75 (30.42 \pm 0.29) 32.5	12.5 (13.58 \pm 0.41) 15.0	17.5 (20.9 \pm 0.43) 25.0	10	2.25	2.25 (3.8 \pm 0.63) 6.0
<i>P. cabulicus</i> (Wag.) E. Nasir	Per-Pr	22.5 (25.7 \pm 0.5) 27.7	12.25 (12.47 \pm 1.20) 12.8	17.5 (18.0 \pm 0.5) 20.0	10	-	1.25 (2.15 \pm 0.25) 2.75
<i>P. stocksii</i> (Boiss.) E. Nasir	Per-Pr	25.0 (25.8 \pm 0.32) 27.25	12.5 (12.6 \pm 0.19) 14.25	15.0 (16.91 \pm 0.28) 20.0	7.5 (7.58 \pm 0.08) 7.75	2.5 (1.5 \pm 0.08) 2.75	1.25 (3.75 \pm 1.25) 5.0
<i>Torilis leptophylla</i> (L.) Reichenb.	Per-Pr	28.75 (30.6 \pm 0.97) 33.75	12.5 (14.9 \pm 0.28) 17.25	15.0 (21.25 \pm 0.75) 25.0	-	-	2.0 (2.10 \pm 0.056) 2.25
<i>Selinum fiticifolium</i> (Edgew.) E. Nasir	Per-Pr	25.0 (27.41 \pm 0.49) 30.0	12.5 (13.01 \pm 0.15) 15.0	12.5 (15.87 \pm 0.53) 17.5	8.75	2.75 (3.75 \pm 1.0) 4.75	2.5 (2.75 \pm 0.071) 3.0
<i>Angelica glauca</i> Edgew.	Per-Pr	33.7 (35.36 \pm 0.38) 37.5	12.75 (14.91 \pm 0.4) 17.5	25 (28.75 \pm 0.66) 30.0	12.5	-	2.0 (2.37 \pm 0.075) 2.75
<i>Ferula oopoda</i> (Boiss. & Bushe) Boiss.	Per-Pr	30.0 (32.0 \pm 1.49) 36.25	12.5 (14.48 \pm 0.25) 16.25	15.0 (24.5 \pm 0.73) 25.0	7.75 (10.12 \pm 2.3) 12.5	-	1.25 (2.30 \pm 0.18) 2.75

Per-pr = per-prolate, Pr = prolate

Table 2. General pollen characters of species found in the pollen type *Pleurospermum hookeri*.

Name of Species	Shape	Polar length of pollen in μm (P)	Equatorial diameter in μm (E)	Colpus length in μm	Apocypium	Mesocolpium	Exine thickness in μm
<i>Pyrenocyclus aucheriana</i> Decne.	Per-Pr	35.0 (39.13 \pm 0.43) 42.5	16.25 (18.63 \pm 0.22) 20.0	12.7 (21.63 \pm 0.81) 25.0	-	-	2.75 (3.4 \pm 0.26) 4.75
<i>Vicatia wolffiana</i> Wolff ex Fedde	Pr.	17.5 (21.82 \pm 0.23) 22.5	12.5 (14.19 \pm 0.22) 12.5	17.5 (21.12 \pm 1.39) 20.0	10.0 (10.12) 10.25	1.75	1.25 (1.45 \pm 0.04) 2.25
<i>Bupleurum subuniflorum</i> Boiss. & Helds	Pr.	20.0 (22.9 \pm 0.33) 24.75	12.5 (14.68 \pm 0.32) 18.75	17.0 (18.5 \pm 2.5) 20.0	10.0 (12.5 \pm 2.5) 15.0	-	1.25
<i>Sexeli libanotis</i> Koch	Per-Pr	27.25 (28.5 \pm 0.7) 37.5	10.0 (12.5 \pm 0.28) 13.75	17.5 (21.38 \pm 0.37) 20.25	-	-	1.25 (1.5 \pm 0.79) 2.0
<i>Carum carvi</i> L.	Pr.	23.25 (26.62 \pm 0.37) 30.5	13.75 (14.85 \pm 0.4) 28.25	20.0 (21.17 \pm 0.08) 22.5	10.0 (11.5 \pm 0.6) 12.5	2.75 (3.75 \pm 0.52) 5.0	1.5 (1.93 \pm 0.13) 2.25
<i>Scandi pecten-veneris</i> L. Scandix	Per-Pr	45.0 (47.50 \pm 0.33) 50.0	17.5 (20.80 \pm 0.31) 25.0	20.0 (23.3 \pm 0.89) 40.0	c. 4.50	c. 4.5	1.25 (2.36 \pm 0.08) 2.75
<i>Selinum varginatum</i> (Edgew.) Clarke	Per-Pr	30.0 (32.20 \pm 0.28) 35.0	13.75 (16.18 \pm 0.34) 20.0	25.0 (27.88 \pm 0.311) 30.0	2.25 (2.37 \pm 0.12) 2.5	2.25 (2.3 \pm 0.12) 2.5	2.7 (3.25 \pm 0.4) 3.75
<i>Platytenia lasiocarpa</i> (Boiss.) Rech. F. & Riedl.	Per-Pr	22.5 (35.5 \pm 1.27) 48.75	13.75 (16.51 \pm 0.37) 19.75	17.5 (21.16 \pm 0.48) 25.0	4.75 (4.91 \pm 0.89) 5.0	-	2.5 (2.53 \pm 0.02) 2.75
<i>Trachydium roylei</i> Lindl.	Per-Pr	25.0 (29.8 \pm 0.45) 32.5	20.0 (23.5 \pm 0.52) 27.5	12.5 (13.5 \pm 0.22) 15.0	-	-	1.5 (2.07 \pm 0.09) 2.25
<i>Pleurospermum styosum</i> Clarke	Pr.	23.75 (26.02 \pm 0.26) 28.0	17.5 (20.93 \pm 1.59) 20.0	17.5 (20.9 \pm 1.59) 20.0	17.5	1.25 (2.68 \pm 0.59) 3.75	1.25 (1.5 \pm 0.25) 1.75
<i>P. hookeri</i> Clarke	Per-Pr	22.5 (31.10 \pm 0.33) 32.5	12.5 (74.30 \pm 0.5) 15.0	17.5 (20.2 \pm 0.76) 21.25	8.75	2.5 (2.62 \pm 0.072) 2.75	2.25 (2.5 \pm 2.8) 2.75
<i>Domema aureum</i> Stocks	Per-Pr	26.25 (29.5 \pm 0.27) 32.5	12.5 (16.07 \pm 0.0) 18.7	20 (23.13 \pm 0.30) 35.0	-	2.0 (2.28 \pm 0.10) 2.75	2.0 (2.28 \pm 0.107) 2.75
<i>Ferula costata</i> Kor. ex E. Nasir	Per-Pr	32.5 (35.86) 32.5	17.5 (19.96 \pm 0.22) 20.0	22.5 (29.61 \pm 0.28) 32.7	17.5 (18.75 \pm 1.24) 20.0	c. 2.5	1.25 (2.16 \pm 0.4) 2.75
<i>Ornopterum tuberosum</i> E. Nasir	Pr.	18 (22.23 \pm 0.78) 25.25	7.75 (9.81 \pm 0.3) 12.5	13.75 (16.95 \pm 0.5) 20.0	-	-	20

Per-pr = per-prolate, Pr = prolate

Table 3. General pollen characters of species found in the pollen type *Trachyspermum ammi*.

Name of Species	Shape	Polar length of pollen in μm (P)	Equatorial diameter in μm (E)	Colpus length in μm	Apoecolpium μm	Mesocolpium μm	Exine thickness in μm
<i>Stium latijugum</i> Clarke	Pr.	22.5 (26.5 \pm 0.38) 30.0	10.0 (14.0 \pm 0.29) 15.0	18.7 (22.78 \pm 0.4) 25.0	10	-	0.75 (0.87 \pm 5.6) 1.0
<i>Sanicula elata</i> Ham. ex Don.	Pr.	32.5 (36.62 \pm 0.42) 40.25	20 (22.90 \pm 0.42) 25.0	30.0 (31.85 \pm 0.47) 37.5	-	-	1.25 (1.4 \pm 0.06) 1.07
<i>Ammi majus</i> L.	Per-Pr	27.5 (31.17 \pm 0.45) 35.0	12.5 (15.5 \pm 0.09) 17.5	17.5 (22.18 \pm 1.14) 25.0	18.75	3.75	2.25 (2.35 \pm 0.009) 2.75
<i>Trachyspermum ammi</i> (L.) Sprague	Per-Pr	25.0 (25.2 \pm 0.43) 28.5	11.0 (10.91 \pm 0.70) 13.75	15.0 (17.41 \pm 0.35) 20.0	-	-	1.25 (2.02 \pm 0.9) 2.25
<i>Scaligeria aitchisonii</i> Wolff.	Per-Pr	25.0 (28.5 \pm 0.39) 32.5	11.25 (13.79 \pm 0.29) 15.0	15.0 (20.5 \pm 0.5) 22.5	1.25 (1.83 \pm 0.62) 2.5	2.25 (2.5 \pm 0.15) 5.0	1.5 (1.9 \pm 0.21) 2.25
<i>Pommageton bitermatum</i> Edgew.	Pr.	28.7 (31.5 \pm 0.2) 33.0	10.0 (12.61 \pm 0.16) 13.75	20.25 (23.70 \pm 0.48) 28.75	c. 7.5	-	1.25 (2.9 \pm 1.2) 5.25
<i>Heraclium candicans</i> Wall ex. DC	Pr.	32.5 (34.9 \pm 0.54) 40.0	13.75 (16.14 \pm 0.131) 18.75	17.5 (21.87 \pm 0.8) 25.0	c. 3.75	c.375	2.0 (2.41 \pm 0.7) 2.75
<i>H. cachemiricum</i> Clarke	Pr.	32.7 (33.6 \pm 0.46) 37.5	13.0 (14.75 \pm 6.11) 15.0	17.5 (20.27 \pm 0.56) 25.0	1.7.5	c.2.5	2.25 (2.35 \pm 0.39) 2.75
<i>H. canescens</i> Lindl.	Pr.	32.5 (37.15 \pm 0.04) 40.0	15.0 (16.1 \pm 18.75) 30.0	22.5 (24.8 \pm 2.01) 30.0	c. 12.5	-	1.75 (2.05 \pm 0.65) 2.5
<i>Platyachia multicaule</i> E. Nasir	Pr.	30.0 (32.83 \pm 0.46) 35.0	12.5 (15.95 \pm 0.3) 17.75	17.5 (21.02 \pm 0.98) 25.0	2.5 (3.37 \pm 0.23) 3.75	-	2.25 (2.5 \pm 0.15) 3.75
<i>Ferula jaeschkeana</i> Vatke	Pr.	20.0 (23.17 \pm 0.30) 25.25	15.0 (17.6 \pm 0.33) 20.0	16.25 (19.68 \pm 0.51) 22.5	5.0 (5.9 \pm 0.59) 7.5	2.5 (2.9 \pm 0.29) 3.75	1.25 1.25

Per-pr = per-prolate, Pr = prolate

Fig. 1. Scanning micrographs: *Pimpinella peberula*: A, Exine pattern; B, Equatorial view. *Psammogeton stocksii*: C, Equatorial view. D, Exine pattern. *Trachyspermum stewartii*: E, Equatorial view, F, Exine pattern.
Scale bar = B, C & E = 10; A & D, F = 1 μ m.

Fig. 2. Scanning micrographs: *Bupleurum gilesii*: A & B Equatorial view. *Bupleurum nigrescens*: C, Equatorial view; D, Exine pattern. *Oenanthe javanica*: E, Exine pattern; F, Equatorial view. Scale bar = A, B, C, F= 10; D & E = 1 μ m.

Species included: *Angelica glauca* Edgew, *Bupleurum tenue* Buch-Ham. ex Don, *B.nigrescens* E Nasir, *B.exaltatum* M. Bieb., *B. falcatum* L., *gilesii* Wolff., *B. linearifolium* DC., *B. marginatum* Wall. ex DC., *Chaerophyllum reflexum* Lindl., *C. villosum* Wall ex DC. *Ferula oopoda* (Boiss. & Buhse) Boiss., *Oenanthe javanica* (Blume) DC., *Pimpinella puberula* (DC.) Boiss., *P. diversifolia* DC., *P. stewartii* (Dum) E. Nasir, *Psammogeton canescens* (DC.) Vatke, *P. cabulicus* (Wag.) E. Nasir, *P. stocksii* (Boiss.) E. Nasir, *Selinum filicifolium* (Edgew.) E. Nasir, *Torilis leptophylla* (L.) Reichb., *Trachyspermum stewartii* (Dunn) Hedge. Lamond & Rochy.

Key to the groups

- 1 + Pollen grains per-prolate sub-group-I *Angelica glauca* Edgew, *Chaerophyllum relexum* Lindl, *Ferula oopoda* (Boiss. & Buhse) Boiss., *Oenanthe javanica* (Blume) DC., *P. stewartii* (Dum) E. Nasir, *Psammogeton canescens* (DC.) Vatke, *P. cabulicus* (Wag.) E. Nasir, *P. stocksii* (Boiss.) E. Nasir, *Selinum filicifolium* (Edgew.) E. Nasir, *Torilis leptophylla* (L.) Reichb.
- Pollen grains prolate Sub-group-II *Bupleurum tenue* Buch-Ham. ex Don, *B.nigrescens* E Nasir, *B.exaltatum* M. Bieb., *B. falcatum* L., *gilesii* Wolff., *B. linearifolium* DC., *B. marginatum* Wall. ex DC., *C. villosum* Wall ex DC. *Pimpinella puberula* (DC.) Boiss., *P. diversifolia* DC., *Trachyspermum stewartii* (Dunn) Hedge. Lamond & Rochy.

II: *Pleurospermum hookeri*-type (Fig. 3. A-E).

Pollen class: 3 -colporate, 3-zonocolporate.

P/E ratio: 0.85-0.93.

Aperture: Ectoaperture-colpus long, sunken, narrow, end acute. Endoaperture circular

Exine: Sexine thicker or than nexine.

Ornamentation: Rugulate-striate.

Outline: Equatorial view elliptic, polar view triangular.

Measurements: Polar axis (P) 17.1 (32.5± 0.61) 48.2 µm. Equatorial diameter (E) 10.26 (19.5.12 ± 0.1) 28.21 µm. Mesocolpium 1.75 (3.6 ± 0.12) 5.5 µm colpus 12.5 (21.3 ± 0.25) 30.5 µm. Exine 1.25 (2.12 ± 0.37) 3.1 µm thick.

Species included: *Bupleurum subuniflorum* Boiss. & Heldr, *Carum carvi* L., *Ferula costata*, *Dorema aureum* Stocks, *Pleurospermum hookeri* Clarke, *Ormopterum tuberosum* E. Nasir, *P. stylosum*, *Pycnocycla aucheriana* Decne., *Platytaenia lasiocarpa* (Boiss.) Rech.f. & Reidl., *Scandix pecten-veneris* L., *Selinum varigatum* (Edgew.) Clarke, *Seseli libanotis* (L.) Koch, *Trachydium roylei* Lindl., and *Vicatia wolffiana* Wolf ex Fedde.

Key to the species

- 1 + Pollen grains prolate *Bupleurum subuniflorum* Boiss. & Heldr, *Carum carvi* L., *Ferula costata*, *Dorema aureum* Stocks, *Pleurospermum stylosum*, *Vicatia wolffiana* Wolff ex Fedde
- Pollen grains per-prolate *Pleurospermum hookeri* Clarke, *Pycnocycla aucheriana* Decne., *Platytaenia lasiocarpa* (Boiss.) Rech.f. & Reidl., *Scandix pecten-veneris* L., *Selinum varigatum* (Edgew.) Clarke, *Seseli libanotis* (L.) Koch, *Trachydium roylei* Lindl., and *Ormopterum tuberosum* E. Nasir

Fig. 3. Scanning micrographs: *Carum carvi*: A, Exine pattern, B, Equatorial view. *Ferula costata*: C, Equatorial view, D, Exine pattern. *Pleurospermum stylosa*: E, Equatorial view; F, Exine pattern
Scale bar =B, C, E = 10; A, D & F= 1 μ m.

III: *Trachyspermum ammi*-type (Fig. 4. A-E).**Pollen class:** 3-colporate, 3-zonocolporate.**P/E ratio:** 0.87-1.200.**Shape:** Per-prolate to prolate.**Aperture:** Ectoaperture-colpus not sunken long margin irregular, end acute
Endoaperture: circular.**Exine:** Sexine thicker or thinner than nexine or as thick as nexine.**Ornamentation:** Tectum striate.**Outline:** Equatorial view elliptic, polar view trilobed.**Measurements:** Polar axis (P) 22.4 (31.4 ± 1.25) 40.5 µm, Equatorial diameter 11.01 (18.5 ± 1.25) 25.5 µm and colpus length 15.5 (17.5 ± 0.31) 20.5 µm long. Colpal membrane granulated. Mesocolpium 2.5 (5.11 ± 1.11) 7.5 µm. Apocolpium 2.5 (5 ± 0.11) 3.75 µm. Exine 1.25 (2.51 ± 1.11) 3.75.**Species included:** *Ammi majus* L., *Ferula jaeschkeana* Vatke, *Heracleum candicum* Wall ex DC., *H. cachemicum* Clarke, *H. canescens* Lindl., *Platytaenia multicaule* E. Nasir, *Psammageton biternatum* Edgew., *Sanicula elata* Ham. ex Don., *Scaligeria aitchisonii* Wolff, *Sium latijugum* Clarke., and *Trachyspermum ammi* Sprague**Key to the species and species groups**

- 1 + Pollen grains per-prolate..... *Ammi majus* L., *Heracleum candicum* Wall ex DC., *H. cachemicum* Clarke, *H. canescens* Lindl., *Platytaenia multicaule* (Boiss.) Rech.f. & Reidl., *Psammageton biternatum* Edgew., *Scaligeria aitchisonii* Wolff, and *Trachyspermum ammi* Sprague
 Pollen grains prolate *Ferula jaeschkeana* Vatke, *Sanicula elata* Ham. ex Don., *Sium latijugum* Clarke.

Discussion

Umbelliferae is a Stenopalynous family (Erdtman, 1952). Pollen morphology of 50 species representing 27 genera viz., *Trachyspermum*, *Sium*, *Sanicula*, *Qenanthe*, *Ammi*, *Pyncocycla*, *Vicatia*, *Bupleurum*, *Pimpinella* *Seseli*, *Scaligeria*, *Ferula*, *Carum*, *Chaerophyllum*, *Scandix*, *Psammogeton*, *Torilis*, *Turgeria*, *Schultzia*, *Selinum*, *Heracleum*, *Angelica*, *Platytaenia*, *Ormopterum*, *Trachydium*, *Pleurospermum*, and *Dorema* has been examined by light and scanning microscope. Pollen grains are remarkably uniform in their pollen characters. Pollen grains of Umbelliferae is generally tricolporate with thick costae, shape of the grains varies from prolate-perprolate. Tectum is uniformly striate to striate-rugulate. P/E ratio ranges from 1.182 to 2.6. On the basis of tectum, 3 distinct pollen types are recognized viz., *Bupleurum gilessii*-type, *Pleurospermum hookeri*-type, *Trachyspermum ammi*-type.

Pollen type-I: *Bupleurum gilessii*-type is characterized by its striate-rugulate tectum. 21 species are included in this pollen type. Pollen type - II: *Pleurospermum hookeri* type is recognized by its rugulate-striate pollen. It comprises of 14 species (see key to the species). Pollen type-III: *Trachyspermum ammi* is easily delimited by having striate tectum, 12 species are present in this type. Although, the species of this pollen type are fairly uniform in their pollen character but on the basis of pollen shape species of these types can be divided into two group (see Account of pollen types).

Fig. 4. Scanning micrographs: *Heracleum cachmeriana*: A, Equatorial view; B, Exine pattern. *H. cadicaus*: C, Exine pattern, D, Equatorial view. *Scaligera aitchisonii*: E, Exine surface, F, Equatorial view.
Scale bar = A, D & F = 10; B, C & E = 1 μ m.

Cerceau-Larrival (1962) divided the pollen of Umbelliferae into 4 distinct types based on P/E ration viz., sub rhomboidal type-1 (P/E = 1-1.5), Sub circular type-II (P/E ratio 1-1.5), Oval type-III (P/E = 1.5-2), sub-rectangular type –IV (P/E ration = 2), Equatorially constricted type-V (P/E ration = over 2). Van Zeist *et al.*, (1977) also divided the pollen grains of Umbelliferae into nine pollen types i.e., *Anisoscidium*-type, *Bunium*-type, *Bupleurum*-type, *Eryngium*-type, *Ferula*-type, *Malabaila*-type, *Pimpinella*-type, *Sium*-type, *Erectum* -type and *Thurgenia*-type. In the present study all the taxa examined belong to all the pollen types of Cerceau-Larrival i.e., sub rhomboidal, type with P/E 1-1.5 to equatorially constricted type with P/E more than 2. Other Pollen characters such as exine thickness, colp membrane and amb of the grains are of little taxonomic value and can rarely be useful at specific level. Like in the genus *Chaerophyllum*, one of its species i.e. *C. reflexum* Lindl., has fossaperturate pollen grains, while the other species of same genus i.e. in *C. villosum* Wall. ex DC. Planaperturate grains are found. According to Punt (1984) pollen grains of Umbelliferae are very distinctive with their characteristic inner and outer outlines, slit-like ectocolpi and broad, band-like costae, most important reorganization character is bone shape pollen. He divided the family into numbers of pollen types.

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