

POLLEN MORPHOLOGY OF THE TRIBE ANTHEMIDAE: COMPOSITAE FROM PAKISTAN AND KASHMIR

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ABSTRACT

Pollen morphology of 45 species representing 11 genera of the tribe Anthemidae: Compositae from Pakistan and Kashmir have been examined by light and scanning microscopes. The Anthemidae:Compositae is more or less stenopalynous tribe. However, Pollen morphology of the tribe is significantly helpful at the specific level. Pollen grains are generally radially symmetrical, isopolar, Oblate – spheroidal to prolate-spheroidal, rarely prolate to sub-prolate. Aperture tricolporate. Tectum commonly spinulose few species have non-echinate pollen. On the basis of tectum two distinct pollen type are recognized. Type –I: spinulose pollen and Type – II. Non spinulose pollen.

Key-words: Compositae, pollen morphology, *Achillea*, *Anthemis*, *Chrysanthemum*, *Tanacetum*, *Artimisia*, Pakistan.

INTRODUCTION

Compositae is a family of about 1100 genera and 23,000 species, distributed in 3 subfamilies and 17 tribes viz., Anthemideae, Arctoteae, Astereae, Calenduleae, Cardueae, Eupatorieae, Gnaphalieae, Heliantheae, Helenieae, Inuleae, Lactuceae, Mutisieae, Plucheeae and Senecioneae (Willis 1973, Mabberley 1987). Anthemideae represented by c. 1750 genera and c. 110 species. In Pakistan it is distributed by 22 genera and 91 species (Ghafoor, 2002).

Plants are annual and perennial herbs and shrubs, leaves alternate, rarely opposite, capitula radiate, disciform or discoid, phyllaries imbricate, anther ecaudate, rarely shortly caudate. The chief genera are *Achillea*, *Anthemis*, *Chrysanthemum*, *Tanacetum* and *Artimisia*.

Pollen characters provide important information for plant taxonomy, evolution, pollination and plant breeding. The correct identification of pollen is important in the study of vegetation and climatic history, in forensic science, in the analysis of origins of honey and beeswax and in the alleviation of hayfever (aeropalynology).

Number of workers have been examined pollen morphology of family Compositae such as Stix (1966), Nair (1962), Faegri and Iversen. (1964), Skvarla and Turner (1966), Moore and Webb (1978). Praglowski and Grafstrom (1980) studied the pollen morphology of tribe Calenduleae in relation to taxonomy. Salgado-Labouriau (1978, 1982ab, 1983) examined pollen morphology of some members of family Compositae. Mesfine et al., (1995) studied the pollen morphology of North American *Coreopsis* (Compositae--Heliantheae). However, pollen morphology of few genera of tribe Anthemideae have been studied by Belkina (1975), Chaubal (1976), Vartak and Seethalakshmi (1976), Markgraf, and D'Antoni (1988). There are no reports on pollen morphology of Anthemideae from Pakistan. However, Perveen and Qaiser (1997) examined few species of Compositae pollen while studying pollen Flora of Pakistan. Dawar *et al.*, (2002) examined the pollen morphology of the genus *Inula* L. (s.str.) and its allied genera (Inuleae -Compositae) from Pakistan and Kashmir. Present pollen data provide pollen morphology of 44 species representing 11 genera belonging to tribe Anthemideae: Compositae from Pakistan and Kashmir by scanning and light microscopes.

MATERIALS AND METHODS

Pollen samples were collected from Karachi University Herbarium (KUH) or from the field. The pollen slides were prepared for light (LM) and scanning electron microscopy (SEM) by the standard methods described by Erdtman (1952).

For light microscopy: Pollen grains were mounted in unstained glycerine jelly and observations were made with a Nikon Type-2 microscope under (E40, 0.65) and oil immersion (E100, 1.25), using 10x eye piece.

For Scanning Electron microscopy: Pollen grains suspended in a drop of water is directly transferred with a fine pipette to a metallic stub using double sided cellotape and coated with gold in a sputtering chamber. Coating was restricted to 3000Å. The S.E.M examination was carried out on a Jeol microscope JSM-3680A. The measurements were based on 15-20 readings from each specimen. Polar length, equatorial diameter, colpus length and exine thickness (Table I).

RESULTS AND OBSERVATIONS

Achillea L.

Pollen grains radially symmetrical isopolar, oblate-spheroidal to prolate-spheroidal, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose.

A genus of about 115 species, distributed in Eurasia and Mediterranean region. In Pakistan it is distributed by 5 species (Ghafoor, 2002).

Key to the species

1. + Pollen grains prolate-spheroidal.....2
- Pollen grains oblate-spheroidal.....3
2. + Copli 13.2 μm long*Achillea wilhelmsii*
- Colpi 26.4 μm long.....*A.millefolium* subsp. *chitralensis*
3. + Apocolpium 6.1 μm *A. filipendulina*
- Apocolpium 16.5.....*A.millefolium* subsp. *millefolium*

***Achillea biebersteinii* Afan.**

P/E ratio: 0.99

Size: Polar axis (P) 18.15 (23.1) 23.76 μm , Equatorial diameter (E) 17.5 (23.2) 24.6 μm

Oblate – spheroidal, tricolporate, trilobed, to fossaperurate, colpi (16.5) 19.2(20.3) μm long. Mesocolpium 22.3 μm . Apocolpium 2.2 μm . Exine 2.8 μm . Tectum echinate. Sexine thicker than nexine.

***Achillea filipendulina* Lam.**

P/E ratio: 0.86

Size: Polar axis (P) 23.4 (26.02) 28.3 μm thick, Equatorial diameter (E) 28.1 (30.1) 33.5 μm .

Oblate-spheroidal, tricolporate, trilobed, to fossaperurate, colpi 18.2 (20.7) 21.8 μm long. Mesocolpium 17.2 (22.3) 23.1 μm . Apocolpium 6.31 μm . Sexine thicker than nexine. Exine 4.3 μm thick. Tectum echinate.

***Achillea millefolium* L. subsp. *chitralensis* Hub.-Mor.**

P/E ratio: 1.01

Size: Polar axis (P) 23.1 (26.4) 27.8 μm , Equatorial diameter (E) 22.8 (26.4) 28.8 μm .

Prolate-spheroidal, tricolporate, trilobed, fossaperurate, colpi 26.4 μm long. Mesocolpium 19.8 μm . Apocolpium 9.9 μm . Sexine thicker than nexine. Exine c. 4.95 μm thick. Tectum spinulose.

***Achillea millefolium* subsp. *millefolium* L. (Fig.1 A & B).**

P/E ratio: 0.95

Size: Polar axis (P) 24.7 (25.55) 26.4 μm . Equatorial diameter (E) 24.2 (26.7) 27.1 μm .

Oblate-spheroidal, tricolporate, trilobed, to fossaperurate, colpi c. 16.5 μm thick. Mesocolpium 17.5 μm . Apocolpium 8.25 μm . Sexine thicker than nexine. Tectum spinulose.

***Achillea wilhelmsii* C. Koch.**

P/E ratio: 1.07

Size: Polar axis (P) 23.1 μm thick, Equatorial diameter (E) 21.4 μm .

Prolate-spheroidal, tricolporate, trilobed, to fossaperurate, colpi 13.2 μm long. Mesocolpium c. 21.4 μm . Apocolpium c. 5.94 μm . Sexine thicker than nexine. Exine c. 5.94 μm thick. Tectum spinulose. Environmental horizon

***Allardia* Decne.**

Pollen grains radially symmetrical isopolar, oblate-spheroidal to sub-prolate, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose

A small genus of about 8 species, distributed in Afghanistan, Central Asia, Pakistan and China. In Pakistan it is distributed by 6 species.
(Ghafoor,2002)

Allardia glabra Decne. (Fig.1 E & F).

P/E ratio: 1.17

Size: Polar axis (P) 21.2 (23.1) 24.4 µm. Equatorial diameter (E) 18.5 (19.6) 20.1 µm.

Sub-prolate, tricolporate, trilobed, to fossaperurate, colpi 17.6 µm long. Mesocolpium 12.3 µm. Apocolpium 4.3 µm. Sexine thicker than nexine. Exine 6.34 µm thick. Tectum echinate.

Allardia tomentosa Decne. (Fig.1 G & H).

P/E ratio: 1.15

Size: Polar axis (P) 20.2 (22.1) 24.4 µm. Equatorial diameter (E) 17.5 (19.5) 21.1 µm.

Sub-prolate, tricolporate, trilobed, to fossaperurate, colpi 16.2 µm long. Mesocolpium 11.4 µm. Apocolpium 5.3 µm. Sexine thicker than nexine. Exine 7.02 µm thick. Tectum spinulose.

Artemisia L.

Pollen grains radially symmetrical isopolar, oblate-spheroidal to prolate-spheroidal rarely prolate to sub-prolate, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose.

A genus of about 388 species, distributed mainly in north temperate regions of both new and old world. In Pakistan it is distributed by 25 species
(Ghafoor,2002)

Key to the species

1. + Pollen grains sup-prolate to prolate.....2
- Pollen grains oblate-spheroidal to prolate-spheroidal.....5
2. + Pollen grains prolate.....3
- Pollen grains subprolate*A.rutifolia*
3. + Copli 15.2-17.5 um long *Artemisia capillaris*
- Colpi 20.-22.7 um long.....*A.elegantissima*
5. + Pollen grains prolate-spheroidal.....Group.I. *Artemisia salsoloides*
(*A. incise*, *A. gmelinii*, *A. parviflora*,
A. salsoloides, *A.scoparia*, *A.vulgari*),

- Pollen grains oblate-spheroidal.....Group.II .
(*Artemisia biennis*, *Artemisia draunculus* , *A. japonica*,
A.lacinata, *A.stricta*, *A. sieversiana*, *A. persica*)

Artemisia biennis Willd.

P/E ratio: 0.93

Size: Polar axis P 20, um and Equatorial diameter E = 21.5 µm.

Oblate- spheroidal, tricolporate, trilobed, to fossaperurate, colpi c.15 µm. Mesocolpium (12.5- 13.66 ± 0.42 (-15) µm. Apocolpium 2.5 µm. Exine c.2.25 µm thick, sexine thicker nexine. Tectum spinulose.

Artemisia capillaris Thunb.

P/E ratio: 1.15

Size: Polar axis P (18.75-) 19.35 ± 0.25 (-20) µm, and Equatorial diameter E (15-) 15.75 ± 0.44(17.5) µm.

Prolate, tricolporate, trilobed, fossaperturate, colpi (15-) 16.5 ± 0.54 (-17.5) µm long. Mesocolpium c. 12.5 µm. Apocolpium c.2.75 µm. Exine c.4.25 µm thick, sexine thicker than nexine. Tectum spinulose. P.A.I: 1.21.

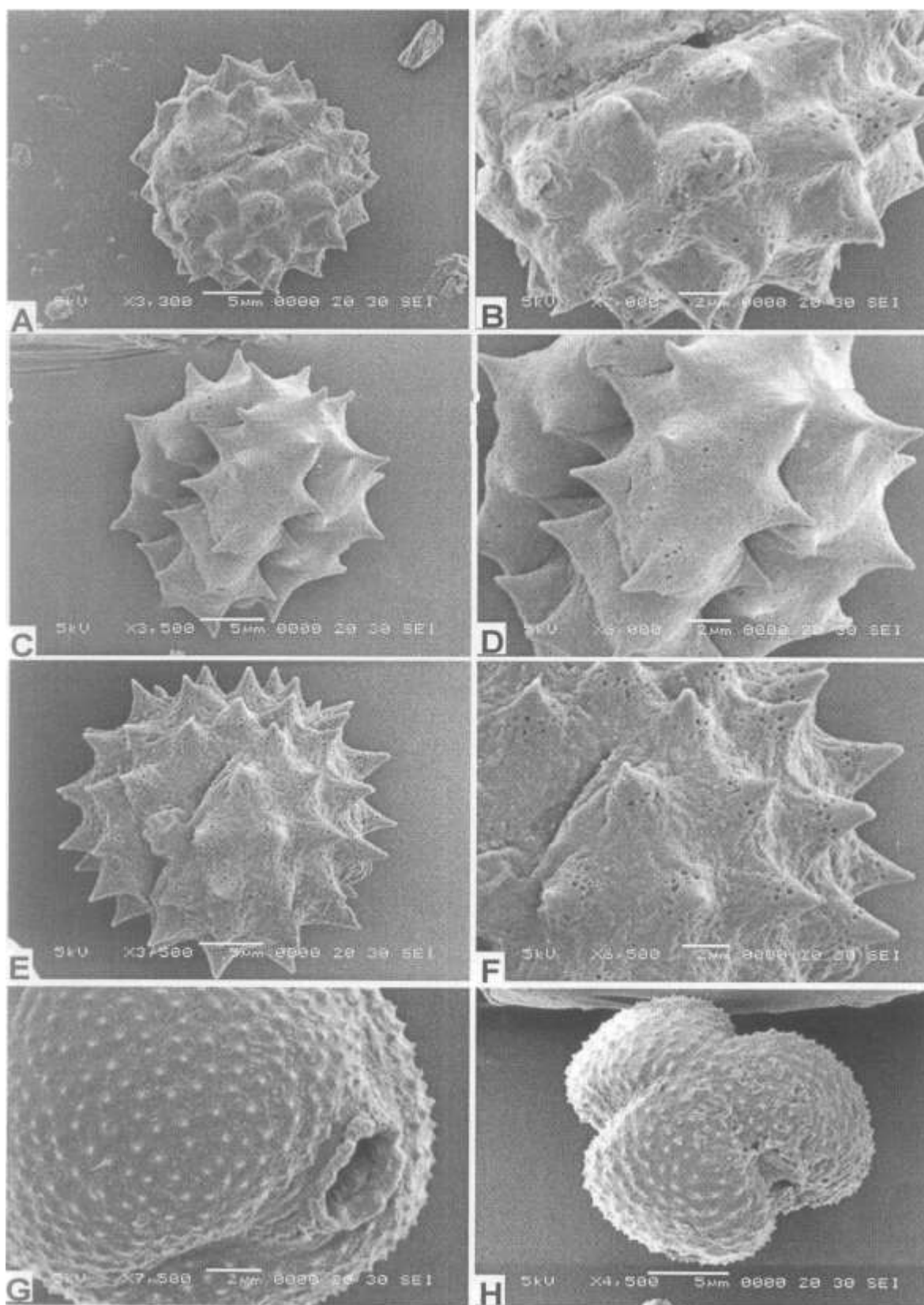


Fig. 1. Scanning Electron micrographs of pollen grains. *Achillea millefolium*: A, Equatorial view, B, Exine pattern. *Seriphidium brevifolium*: C, Equatorial view, D, Exine pattern. *Allardia glabra*: E, Polar view, F, Exine pattern. *Allardia tomentosa*: G, Exine pattern; H, Polar view. Scale bar = A, C, E & H = 5 μ m; B, D, F & G = 2 μ m.

***Artemisia draunculus* L.**

P/E ratio: 0.88

Size: Polar axis P = 20, and Equatorial diameter E = 22 μm .Oblate - spheroidal, tricolporate, trilobed, fossaperturate, colpi 17.5 μm long. Mesocolpium (12.5-) 13 $\pm$ 0.54 (-15) μm . Apocolpium c.0.0.5 μm . Exine c.2.75 μm thick, sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.69.

***Artemisia elegantissima* Pamp.**

P/E ratio: 1.03

Size: Polar axis P (25.-) 25.8 $\pm$ 0.68 (-27.5) μm , and Equatorial diameter E (20.25-) 25.08 $\pm$ 1.77 (-27.5) μm .Prolate, tricolporate, trilobed, fossaperturate, colpi (20-) 21.58 $\pm$ 0.64 (-22.57) μm long. Mesocolpium (15-) 16.65 $\pm$ 1.46 (-17.5) μm . Apocolpium 0.1.25 μm . Exine (4-)4.25 $\pm$ 0.17 (-4.5) μm thick, Exine thicker than nexine. Tectum spinulose.

P.A.I: 1.50.

***Artemisia gmelinii* Web. ex Stechm.**

P/E ratio: 1.11

Size: Polar axis P (21.25-)23.7 $\pm$ 1.06(-27.5) μm , and Equatorial diameter E (20-)21.25 $\pm$ 0.89(-22.5) μm .Prolate-spheroidal, tricolporate, trilobed, fossaperturate, colpi (17.-1) 19.41 $\pm$ 1.0 μm (-22.5) μm long. Apocolpium obscur. Exine (-3) 4.2 $\pm$ 0.38 (-5) μm thick. sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.41.

***Artemisia incisa* Pamp.**

P/E ratio: 1.01

Size: Polar axis (P) (15-) 17.9 $\pm$ 0.72 (-20) μm , and Equatorial diameter (E) (16.2) 17.7 $\pm$ 0.97. (-18.75) μm .Prolate-spheroidal, tricolporate, trilobed, colpi c. 17.5 μm long. Mesocolpium c. 15 μm . Apocolpium obscure. Exine (2.27-) 32. $\pm$ 0.6 (-3.75) μm thick. Tectum spinulose,

P.A.I: 1.18.

***Artemisia japonica* Thunb.**

P/E ratio: 0.95

Size: Polar axis P (17.75-) 19.12 $\pm$ 0.54 (-20) μm , and Equatorial diameter E 20 μm .Oblate - spheroidal, tricolporate, trilobed, fossaperturate, colpi (15-)15.62 $\pm$ 0.54(-75) μm long. Mesocolpium (12.5) 13.5 $\pm$ 0.84 (-15) μm . Apocolpium c.0.5 μm Exine 3.25 μm thinck, sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.48

***Artemisia laciniata* Willd.**

P/E ratio: 0.91

Size: Polar axis P (20.25-) 21.8 $\pm$ 0.21 (-21.5) μm , and Equatorial diameter E (20.-) 21.87 $\pm$ 1.18(-23.75) μm .Oblate - spheroidal, tricolporate, trilobed, to fossaperturate, colpi (16.75) 16.56 $\pm$ 0.27 (-17.5) μm long. Mesocolpium (10-) 13.12 $\pm$ 1.03 (-16.25) μm . Apocolpium c.25 μm . Exine (3.75-) 4.5 $\pm$ 0.21(-4.75) μm thick. Exine thicker than nexine. Tectum spinulose.

P.A.I: 1.66.

***Artemisia parviflora* Roxb. ex D.Don**

P/E ratio: 1.101.

Size: Polar axis P (17.5-) 19.83 $\pm$ 0.31(-22.5) μm , and Equatorial diameter E (15-) 18 $\pm$ 0.44 (-20) μm .Prolate-spheroidal, tricolporate, trilobed, fossaperturate, colpi (15-) 17.6 $\pm$ 0.24 (-18.75) μm long. Mesocolpium (12.5-) 13.13 $\pm$ 0.59 (15.25) μm . Apocolpium c.2.75 μm . sexine thicker than nexine. Exine c.2.75 μm thick. Tectum spinulose.

P.A.I: 1.37.

***Artemisia persica* Boiss.**

P/E ratio: 0.93

Size: Polar axis P (18.75-) 20.75 ± 0.91 (-23.75) μm , and Equatorial diameter E (20-) 22.08 ± 1.44 (-25) μm .
 Oblate - spheroidal, tricolporate, trilobed, fossaperturte, colpi (15-) 17.18 ± 0.68 (-18.7) μm long. Mesocolpium (12.5-) 14 ± 0.55 (15) μm . Apocolpium c.2.75 μm , sexine thicker than nexine. Exine 3.25 μm thick. Tectum spinulose.
 P.A.I: 1.51.

***Artemisia rutifolia* Spreng.**

P/E ratio: 1.30

Size: Polar axis P (25-) 27.08 ± 0.38 (-27.5) μm and Equatorial diameter E = (18.75-) 20.75 ± 0.97 (-25) μm .
 Sub-prolate, tricolporate, trilobed, to fossaperturate, colpi (22.5-) 22.81 ± 0.27 (-23.75) μm long. Mesocolpium (12.5-) $15. \pm 0.70$ (-15) μm . Apocolpium c. 2.25 μm . Exine c.3.75 μm thick. sexine thicker than nexine. Tectum spinulose.
 P.A.I: 1.38.

***Artemisia salsoloides* Willd.**

P/E ratio: 1.02

Size: Polar axis P (18.75-) 19.75 ± 0.22 (-20) μm , and Equatorial diameter E = (17.5-) 19.37 ± 0.54 (-22.5) μm .
 Prolate - spheroidal, tricolporate, trilobed, fossaperturate, colpi (15-) 15.83 ± 0.48 (-17.5) μm long. Mesocolpium (10.-) 11.93 ± 0.50 (-12.75) μm . Apocolpium (2.15-) 2.25 ± 0.11 (-2.5) μm , sexine thicker than nexine. Tectum spinulose.
 P.A.I: 1.65.

***Artemisia scoparia* Waldst. & Kit**

P/E ratio: 1.03

Size: Polar axis P (16.25-) 19.39 ± 1.10 (-22.5) μm , and Equatorial diameter E (17.5-) 18.75 ± 0.46 (-22.5) μm .
 Prolate - spheroidal, trilobed, fossaperturate, colpi (12.5-) 15.93 ± 0.29 (-18.75) μm long. Mesocolpium (12.5-) 13.35 ± 0.38 (-15) μm . Apocolpium (2.75-) 3.41 ± 0.54 (-4.75) μm . Exine (2.5-) 3.1 ± 0.24 (-3.75) μm , sexine thicker than nexine. Tectum spinulose.
 P.A.I: 1.40

***Artemisia sieversiana* Ehrh.**

P/E ratio: 1.03

Size: Polar axis P (20-) 26.2 ± 0.19 (-21.5) μm , and Equatorial diameter E = 20.
 Oblate - spheroidal. tricolporate, trilobed, to fossaperurct colpi (12.7-) 17 ± 0.88 (-15.25) μm long. Mesocolpium (15) μm . Exine (3.75-) 4.0 ± 0.17 (-4.25) μm thick. Apocolpium 2.5 μm . Sexine thicker nexine. Tectum spinulose.
 P.A.I: 1.33.

***Artemisia stricta* Edgew.**

P/E ratio: 0.95

Size: Polar axis P (18.75-) 19.58 ± 0.24 (-20) μm , and Equatorial diameter E (18.75-) 20.62 ± 0.93 (-20) μm .
 Oblate - spheroidal, tricolporate, trilobed, fossaperturate, colpi (15-) 15.92 ± 0.40 (-175) μm long. Mesocolpium (15-)12.5 0.04 (12.75) μm . Apocolpium c.2.5 μm . Exine (2.5-) 2.58 ± 0.06 (-2.95) μm . Sexine thicker than nexine. Tectum spinulose.
 P.A.I: 1.65.

***Artemisia vulgaris* L.**

P/E ratio: 1.03

Size: Polar axis P (25-) 26.75 ± 0.36 (-30) μm , and Equatorial diameter E = (25-) 26.1 ± 0.6 (-27.5) μm .
 Prolate - spheroidal, tricolporate, trilobed, to fossaperturate, colpi (2.25-) 2.56 ± 0.10 (-2.75) μm diameter. Mesocolpium (12.5-) $15. \pm 0.70$ (-15) μm . Apocolpium c. 2.5 μm , sexine thicker than nexine. Exine (2.25-) 3.08 ± 0.24 (-3) μm thick. Tectum spinulose.

P.A.I: 1.71.

Cotula L.

Pollen grains radially symmetrical isopolar, oblate-spheroidal tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose

A genus of about 55 species, distributed in southern hemisphere. In Pakistan it is distributed by 2 species (Ghafoor,2002)

Cotula anthemoides L.

P/E ratio: 0.98

Size: Polar axis (P) 16.4 (17.4) 18.4 μm . Equatorial diameter (E) 16.5 (17.5) 18.6 μm .

Oblate-spheroidal, tricolporate, trilobed, to fossaperurate, colpi 16.2 μm long. Mesocolpium 28.3 μm . Apocolpium 6.4 μm . Exine 8.36 μm thick. Sexine thicker than nexine. Tectum spinulose.

Leucanthemum Miller

Pollen grains radially symmetrical isopolar, oblate-spheroidal to prolate-spheroidal, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose

A genus of 33 species, distributed thought Europe. In Pakistan it is distributed by One species (Ghafoor,2002)

Leucanthemum vulgare Lam.

P/E ratio: 1.05

Size: Polar axis P (24-) 26.3 5 ± 0.36 (-30) μm , and Equatorial diameter E = (25-) 26.1 ± 0.6 (-27.6) μm .

Prolate-sphereidol, tricolporate, trilobed, to fossaperurate, colpi 14.6 μm long. Mesocolpium 15.8 μm . Apocolpium 5.2 μm . Eexine 5.6 μm thick. Sexine thicker than nexine. Tectum spinulose.

Matricaria L.

Pollen grains radially symmetrical isopolar, oblate-spheroidal, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose

A small genus of about 7 species, widely distributed inEurope. In Pakistan it is distributed by 2 species (Ghafoor,2002)

- 1.+ Polar length of pollen grains 23.1-25.7.....*M. aurea*
- Polar length of pollen grains 26-29.95.....*M.recutita*

Matricaria aurea (Loefl.) Schultz-Bip.

P/E ratio:

Size: Polar axis (P) 23.1 (24.43) 25.76 μm . Equatorial diameter (E) 26.2 (27.7) 29.1 μm .

Oblate-sphereidol, tricolporate, trilobed, to fossaperurate, colpi c. 19.8 μm long. Mesocolpium 19.8 μm . Apocolpium 8.25 μm . Eexine 4.95 μm thick. Tectum spinulose.

Matricaria recutita L.

P/E ratio: 0.96

Size: Length (P) 26.4 (27.3) 28.2 μm . Equatorial diameter (E) 29.7 (29.95) 30.2 μm .

Oblate-sphereidol, tricolporate, trilobed, fossaperurate, colpi (26.2) 29.6 (30.2) μm long. Mesocolpium 29.7 (29.95) 30.1 μm . Apocolpium 3.1 μm . Eexine 3.1 μm thick. Sexine thicker than nexine spinulose

Microcephala Pobed.

Pollen grains radially symmetrical isopolar, proate-spheroidal, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose

A small genus of about 4 species, distributed in Central Asia. In Pakistan it is distributed by one species (Ghafoor,2002)

Microcephala lamellata (Bunge) Pobed.

P/E ratio: 1.07

Size: Polar axis (P) (23.1) μm . Equatorial diameter (E) (21.45) μm .

Prolate-spheroidal, tricolporate, trilobed, to fossaperurate, colpi 21.45 μm long. Mesocolpium 16.5 μm . Apocolpium 8.55 μm . Sexine thicker than nexine. Exine 3.95 μm thick. Tectum spinulose, spinules 3.3 μm long.

Pseudohandelia Tzvelev

Pollen grains radially symmetrical isopolar, oblate-spheroidal, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose

A small genus of about 8 species, distributed in Afghanistan and Central Asia. In Pakistan it is distributed by 6 species (Ghafoor, 2002)

Pseudohandelia umbellifera (Boiss) Tzvelev.

P/E ratio: 1.01

Size: Polar axis (P) 26.1 (28.05) 30.12 μm . Equatorial diameter (E) 27.11 (28.05) 29.1 μm .

Oblate-spheroidal, tricolporate, trilobed, to fossaperurate, colpi 18.15 μm long. Mesocolpium 16.5 (18.15) 19.8 μm . Apocolpium 9.9 μm . Sexine thicker than nexine. Tectum spinulose. Exine 1.65 μm thick.

Seriphidium (Besser ex Hook.) Fourr.

Pollen grains radially symmetrical isopolar, oblate-spheroidal-prolate-spheroidal, rarely sub-prolate to prolate, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose

A genus of about 135 species, distributed in Europe, and temperate Asia. In Pakistan it is distributed by 13 species (Ghafoor, 2002)

Key to the species

1. + Pollen grains sup-prolate *Seriphidium quettense*
 - Pollen grains oblate-spheroidal to prolate-spheroidal 2
2. + Pollen grains prolate-spheroidal *S.kurramense*
 - Pollen grains oblate-spheroidal 3
3. + Exine <4.6 Group I
 (*S.brevifolium*, *S.freitagii*, *S.olivierianum*, *S.stenocephalum*, *S.turanicum*)
 - Exine > 4 *S. glanduligerum*

Seriphidium brevifolium (Wall. ex. DC.) Ling & Y. R. Ling (Fig.1 C & D).

P/E ratio: 0.99

Size: Polar axis P (18.75-) 21.41 $\pm$ 0.95 (20-) 21.5 $\pm$ 0.54 (-22.5) μm .

Oblate - spheroidal, tricolporate, trilobed, to fossaperurate, colpi (17.5) 19.75 $\pm$ 0.4 (22.5) μm long. Mesocolpium c.15 μm . Apocolpium c.3.75 μm . Exine (3.75-) 4.12 $\pm$ 0.20 (-4.5) μm thick. Sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.43.

Seriphidium freitagii (Podlech) Y. R. Ling.

P/E ratio: 0.84

Size: Polar axis (P) 15.5 (16.5) 28.0 μm . Equatorial diameter (E) 18.2 (19.8) 23.1 μm .

Oblate - spheroidal, tricolporate, trilobed, to fossaperurate, colpi 17.5 μm long. Mesocolpium 20.1 μm . Sexine thicker than nexine. Exine 2.97 μm thick. Tectum spinulose. 3.3 μm long.

Seriphidium glanduligerum (Krasch. ex Poljakov) Poljako

P/E ratio: 0.99

Size: Polar axis (P) 20.3 (24.35) 28.4 μm . Equatorial axis (E) 20.6 (24.55) 28.5 μm .

Oblate-spheroidal, tricolporate, trilobed, to fossaperurate, colpi 16.2 μm long. Mesocolpium 28.3 μm . Apocolpium 6.42 μm . Exine 6.83 μm thick. Sexine thicker than nexine. Tectum spinulose.

Seriphidium kurramense (Qazilb.) Y. R. Ling.

P/E ratio: 1.05

Size: Polar axis p (22.5-) 24.5 $\pm$ 0.83 (-27.5) μm , and Equatorial diameter E (22.5-) 23.18 $\pm$ 0.59 (-23.75) μm .

Prolate-spheroidal, tricolporate, trilobed, fossaperturate, colpi (17.5-) 20.25 ± 0.89 (-22.5) μm long. Mesocolpium (12.5) 12.6 ± 0.08 (-12.7) μm . Apocolpium c.1.5 μm . sexine thicker than nexine, Exine (2.5-) 3.33 ± 0.34 (-3.75) μm thick. Tectum spinulose.
P.A.I: 1.83.

Seriphidium oliverianum (J. Gay ex Bess.) K. Bremer. And Humphries ex Y. R. Ling

P/E ratio: 0.93

Size: Polar axis P (17.5-) 18 ± 0.28 (-19.8) μm , and Equatorial diameter E (17.5-) 19.29 ± 0.37 (-20) μm .

Oblate-spheroidal, tricolporate, trilobed, fossaperturate, colpi (15-) 16.4 ± 0.62 (18.75) μm long. Mesocolpium c.12.5 μm . Apocolpium (2.25-) 2.58 ± 0.08 (-2.27) μm . Exine (2.25-) 3.25 ± 0.45 (-3.75) μm thick. sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.54.

Seriphidium quettense (Podlech) Ling

P/E ratio: 1.29

Size: Polar axis P (18.75-) 28.75 ± 0.44 (-23.75) μm , and Equatorial diameter E (21.5-5) 23.18 ± 0.27 (22.5) μm .

Subprolate, tricolporate, trilobed, fossaperturate, colpi (17.5-) 18.75 ± 0.60 (-18.75) μm long. Mesocolpium (12.5-) 15.8 ± 0.69 (-17.5) μm , syncolpate, sexine thicker than nexine. Exine c.2.75 μm thick. Tectum spinulose.

P.A.I: 1.46.

Seriphidium sieberi (Bess.) K. Bremen and Humphries ex. Y. R. Ling

P/E ratio: 1.19

Size: Polar axis P (22.5-) 24.9 ± 0.59 (-25) μm , and Equatorial diameter E (17.5-) 20.8 ± 0.74 (-22.5) μm .

Sub-prolate, tricolporate, colpi (17.5-) 20.2 ± 0.62 (-22.5) μm . Mesocolpium (1-5) 15.35 ± 0.33 (-17) μm . Apocolpium c.05 μm . Exine (3-) 3.68 ± 0.36 (-4.75) μm , sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.35.

Seriphidium stenocephalum (Karsch. ex Poljak.) Poljakov

P/E ratio: 0.98

Size: Polar axis P (17.5-) 20.11 ± 0.83 (-22.7) μm and Equatorial diameter E = (17.5-) 20.35 ± 0.61 (-22.5) μm .

Oblate - spheroidal. tricolporate, trilobed, to fossaperurate, colpi (15-) 17.08 ± 0.64 (-18.55) μm long. Mesocolpium (12.5) 12.87 ± 0.29 (-13) μm . Apocolpium c. 0.25 μm . Exine c.3.75 μm thick, sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.57.

Seriphidium turanicum (Krasch.) Poljakov

P/E ratio: 0.90

Size: Polar axis P (22.5-) μm , and Equatorial diameter E (25-) μm .

Oblate - spheroidal, tricolporate, trilobed, to fossaperurate colpi c. 17.5 μm long. Mesocolpium (15-) 16.25 ± 0.89 (-17.5) μm . Apocolpium obscure. Exine (2.75-) 2.75 ± 0.39 3.75 μm sexine thicker than nexine. Tectum spinulose.

P.A.I: 1.53.

***Tanacetum* L.**

Pollen grains radially symmetrical isopolar, oblate-spheroidal, rarely prolate-spheroidal, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose.

A genus of about 152 species, distributed mainly in Europe, and temperate Asia. In Pakistan it is distributed by 12 species (Ghafoor,2002)

Key to the species

1. + Pollen grains prolate-spheroidal*Tanacetum falconeri*
- Pollen grains oblate-spheroidal2

2. + Pollen grains prolate-spheroidal.....*S.kurramense*
 - Pollen grains oblate-spheroidal.....3

3. + Colpi 16-21 μm*T. parthenium*
 - Colpi more than 21 μmGroup.I
 (*Tanacetum artemisoides*, *T. Pakistanicum*, *T. roylei*,)

***Tanacetum artemisoides* Schultz-Bip. ex Hook. f.**

P/E ratio: 0.79

Size: Polar axis (P) 19.8 (23.1) 26.4 μm . Equatorial diameter (E) 28.7 (29.2) 29.7 μm .

Oblate-spheroidol, tricolporate, trilobed, to fossaperurate, colpi 26.4 (28.0) 29.7 μm long. Mesocolpium 19.8 (21.45) 23.1 μm . Apocolpium 8.25 μm . Sexine thicker than nexine. Tectum spinulose 4.95 μm .

***Tanacetum falconeri* Hook.f.**

P/E ratio: 1.11

Size: Polar axis (P) 20.6 (22.4) 24.6 μm . Equatorial diameter (E) 18.9 (20.1) 21.3 μm .

Prolate-spheroidol, tricolporate, trilobed, to fossaperurate, colpi 20.2 μm long. Mesocolpium 19.4 μm . Apocolpium 6.4 μm . Exine 4.95 μm thick. Sexine thicker than nexine. Tectum spinulose.

***Tanacetum pakistanicum* Podl.**

P/E ratio: 0.84

Size: Polar axis (P) 24.7 (27.03) 29.37 μm . Equatorial diameter (E) 29.7 (32.17) 34.65 μm .

Oblate-spheroidol, tricolporate, trilobed, to fossaperurate, colpi 29.7 μm long. Mesocolpium 19.8 μm . Apocolpium 8.27 μm . Sexine thicker than nexine. Tectum spinulose. Spinulose 3.3 μm long.

***Tanacetum roylei* (DC.) Podlech**

P/E ratio: 0.86

Size: Polar axis (P) 24.2 (26.4) 30.9 μm . Equatorial diameter (E) 28.6 (30.1) 32.8 μm .

Oblate-spheroidol, tricolporate, trilobed, to fossaperurate, colpi 27.3 μm long. Mesocolpium 18.2 μm . Apocolpium 8.3 μm . Sexine thicker than nexine. Tectum spinulose.

***Tanacetum parthenium* (L.) Schultz-Bip.**

P/E ratio: 0.90

Size: Polar axis (P) 23.1 (23.9) 24.75 μm . Equatorial diameter (E) 23.1 (26.4) 29.7 μm .

Oblate-spheroidol, tricolporate, trilobed, fossaperurate, colpi 16.5 (18.97) 21.45 μm long. Mesocolpium 16.5 μm . Apocolpium 8.25 μm . Sexine thicker than nexine. Exine 6.6 μm thick. Tectum spinulose.

***Xylantnemum* Tzvelev**

Pollen grains radially symmetrical isopolar, oblate-spheroidal, tricolporate, trilobed. Sexine thicker than nexine. Tectum spinulose.

A small genus of c. 9 species, distributed in Iran, and Central Asia. In Pakistan it is distributed by 3 species (Ghafoor, 2002)

***Xylantnemum macropodum* (Hemsl. & Lace) R. Bremer and Humphries**

P/E ratio: 0.99

Size: Polar axis (P) 26.4 (29.7) 29.7 μm .. Equatorial diameter (E) 29.7 (29.9) 30.1 μm .

Oblate-spheroidol, tricolporate, trilobed, to fossaperurate, colpi 6.6 μm long. Mesocolpium 19.8 μm . Apocolpium 9.9 μm . Sexine thicker than nexine. Exine 6.6 μm . Tectum spinulose. spinulose 3.3 μm long.

DISCUSSION

Compositae is the largest family of dicotyledons, with more than 1,100 genera and 20,000 species (Cronquist, 1981). Compositae is a well-defined and easily field recognized family. It has number of common but distinctive characters, viz. Capitulum inflorescence, Syngeneceous stamens, rayflorete or discflorete (flower types). However,

the family shows wide range of variation in their floral and reproductive characters and number of workers (Cronquist, 1981) divided the family into various tribes (usually 13-15). Like floral morphology palynology of the family is also unique. It is a eurypalynous family (Erdtman, 1952). The present data is based on 45 species distributed in 11 genera belonging to tribe Anthemideae: Compositae.

On the basis of exine sculpturing 2 distinct pollen types are recognized. Type-I is characterized by nonechinate pollen, seven species are included in this pollen type viz. *Achillea biebersteinii*, *Artemisia elegantissima*, *Leucanthemum vulgare*, *Tanacetum artemisoides*, *Tanacetum falconeri* Hook.f., *Seriphidium sieber* and *Seriphidium quettense* (Podlech) Ling.

Type-II is easily recognized by their spinulose tectum, majority of the species fall in this pollen type viz., *Artemisia biennis* Willd., *Artemisia capillaris* Thunb., *Artemisia draunculus* L., *Achillea filipendulina* Lam., *Allardia glabra* Decne., *Artemisia gmelinii* Web. ex Stechm., *Artemisia incisa* Pamp., *Artemisia japonica* Thunb., *Artemisia laciniata* Willd., *Achillea millefolium* L. subsp. *chitralensis* Hub.-Mor., *Achillea millefolium* subsp. *millefolium*, *Artemisia parviflora* Roxb. ex D.Don, *Artemisia persica* Boiss., *Artemisia rutifolia* Spreng., *Artemisia salsoloides* Willd., *Artemisia scoparia* Waldst. & Kit, *Artemisia sieversiana* Willd., *Artemisia stricta* Edgew., *Artemisia vulgaris* L., *Achillea wilhelmsii* C. Koch., *Cotula anthemoides* L., *Matricaria recutita* L., *Matricaria aurea* (Loefl.) Schultz-Bip., *Microcephala lamellata* (Bunge) Pobed., *Pseudohandelia umbellifera* (Boiss) Tzvelev., *Seriphidium brevifolium* (Wall. ex. DC.) Ling & Y. R. Ling, *Seriphidium glanduligerum* (Krasch. ex Poljakov) Poljako, *Seriphidium kurramense* (Qazilb.) Y. R. Ling., *Seriphidium Freitagii* (Podlech) Y. R. Ling., *Seriphidium oliverianum* (J. Gay ex Boss.) K. Bremer and Humphries ex Y. R. Ling, *Seriphidium stenocephalum* (Karsch. ex Poljak.) Poljakov, *Seriphidium turanicum* (Krasch.) Poljakov, *Tanacetum pakistanicum* Podl., *Tanacetum roylei* (DC.) Podlech, *Tanacetum parthenium* (L.) Schultz-Bip. and *Xylantnemum macropodum* (Hemsl. And Lacc) R. Bremer & Humphries.

On the basis of shape classes this type is further divided into 4 subtypes. Subtype-A included only one species like *Artemisia capillaries*, which has prolate pollen. In the subtype-B species i.e., *Artemisia rutifolia* Spreng. And *Allardia glabra* Decne. and *Artemisia tomentosa* Decen. are found sub-prolate pollen.

In subtype-C prolate – spheroidal pollen are found number of species included in this type i.e., *Artemisia gmelinii* Web. ex Stechm., *Artemisia incisa* Pamp., *Achillea millefolium* L. subsp. *chitralensis* Hub.-Mor., *Artemisia parviflora* Roxb. ex D.Don, *Artemisia salsoloides* Willd., *Artemisia scoparia* Waldst. & Kit, *Artemisia vulgaris* L., *Achillea wilhelmsii* C. Koch., *Leucanthemum vulgare* Lam., *Microcephala lamellata* (Bunge) Pobed., *Seriphidium kurramense* (Qazilb.) Y. R. Ling., *Tanacetum falconeri* Hook.f., However, the rest of the species fall in the subtype-D this subtype have oblate - spheroidal pollen viz., *Artemisia biennis* Willd., *Artemisia draunculus* L., *Achillea filipendulina* Lam., *Artemisia japonica* Thunb., *Artemisia laciniata* Willd., *Achillea millefolium* subsp. *millefolium*, *Artemisia persica* Boiss., *Artemisia sieversiana* Willd., *Artemisia stricta* Edgew., *Cotula anthemoides* L., *Matricaria recutita* L., *Matricaria aurea* (Loefl.) Schultz-Bip., *Pseudohandelia umbellifera* (Boiss) Tzvelev., *Seriphidium brevifolium* (Wall. ex. DC.) Ling & Y. R. Ling, *Seriphidium glanduligerum* (Krasch. ex Poljakov) Poljako, *Seriphidium Freitagii* (Podlech) Y. R. Ling., *Seriphidium oliverianum* (J. Gay ex Boss.) K. Bremer and Humphries ex Y. R. Ling, *Seriphidium stenocephalum* (Karsch. ex Poljak.) Poljakov, *Seriphidium turanicum* (Krasch.) Poljakov, *Tanacetum pakistanicum* Podl., *Tanacetum roylei* (DC.) Podlech., *Tanacetum parthenium* (L.) Schultz-Bip. and *Xylantnemum macropodum* (Hemsl. And Lacc) R. Bremer and Humphries. However, these subtypes are further separated on the basis of polar length, colpi length, exine thickness, mesocolpium and apocolpium. Although, these species belong to 11 different genera of tribe Anthemideae, but the palynology suggests the close relationship of these genera within the tribe Anthemideae.

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