

## TAXONOMIC SIGNIFICANCE OF THE CYPSELA MORPHOLOGY IN THE TRIBE ANTHEMIDEAE (ASTERACEAE) FROM PAKISTAN AND KASHMIR

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### Abstract

The present paper deals with the study of 44 species included in 15 genera of the tribe Anthemideae from Pakistan and Kashmir. Micromorphological characters of cypselas were found significant for taxonomic delimitation for most of the taxa both at the generic and specific levels.

### Introduction

Tribe Anthemideae of the family Asteraceae is represented in Pakistan by 22 genera and 91 species (Ghafoor, 2002) distributed in 9 subtribes *viz.*, Achilleinae, Anthemidinae, Artemisiinae, Chrysantheminae, Cancriniinae, Handeliinae, Leucantheminae, Matricariinae, and Tanacetinae (Bremer, 1994). In the family Asteraceae, micromorphological characters of cypselas have been proved very rewarding to delimit the various taxa (Dittrich, 1968; Merxmuller & Grau, 1977; Haque & Godward 1984; Mateu & Guemes, 1993; Abid & Qaiser, 2002; 2007a,b; 2008a,b; Zhu *et al.*, 2006). Attention was also paid to the cypselas of some of the genera of the tribe Anthemideae (Kynclova, 1970; Lovell *et al.*, 1986; Swelankomo *et al.*, 2007; Abid & Qaiser, 2008c) but still there is no detail information about the cypselas morphology for entire tribe of Anthemideae. Studies on micromorphology of cypselas were carried out to provide the strength to the systematic position of taxa in the tribe Anthemideae from Pakistan.

### Materials and Methods

Forty four taxa of the tribe Anthemideae assembled in 15 genera *viz.*, *Achillea*, *Ajania*, *Allardia*, *Anthemis*, *Chrysanthemum*, *Cotula*, *Leucanthemum*, *Matricaria*, *Microcephala*, *Richteria*, *Seriphidium*, *Tanacetopsis*, *Tanacetum*, *Tripleurospermum* and *Xylanthemum* were studied for cypselas characters from herbarium specimens (Appendix-1) under stereomicroscope (Nikon XN Model), compound microscope (Nikon Type 102) and scanning electron microscope (JSM-6380A). For scanning electron microscopy mature cypselas were directly mounted on metallic stub using double adhesive tape and coated with gold for a period of 6 minutes in sputtering chamber and observed under SEM.

The following characters were studied: Cypselas: Shape, surface, colour, size. Pappus: Structure, number, colour, size. Carpopodium: Shape, position, diameter of carpopodium and diameter of foramen of carpopodium were observed under scanning electron microscope.

## Appendix-1. List of voucher specimens.

Taxa	Collector, Number and Herbarium
<i>Achillea filipendulina</i>	M. Qaiser & A. Ghafoor 1409 (KUH, RAW).
<i>A. millefolium</i> subsp. <i>millefolium</i>	S. Abedin & M. Qaiser 8927 (KUH); M. Qaiser & A. Ghafoor 5479 (KUH); S. Abedin & M. Qaiser 9206 (KUH); A. Ghafoor & Tahir Ali 4124 (KUH); S.M.H. Jafri 3383 (KUH).
<i>A. setacea</i>	M. Qaiser & A. Ghafoor 2030(KUH).
<i>A. wilhelmsii</i>	Tahir Ali & G. R. Sarwar 2601 (KUH); M. Qaiser & A. Ghafoor 1302 (KUH); M.A. Siddiqui 20586 (RAW); M. Qaiser & A. Ghafoor 1222 (KUH); A. Ghafoor & Steve M. Goodman 5077 (KUH).
<i>Ajania fruticulosa</i>	S.M.H. Jafri 696 (KUH); A. Ghafoor & S. Omer 2194.
<i>Allardia glabra</i>	R.R. Stewart 12604 (RAW); Shaukat Ali 170 (RAW).
<i>A. nivea</i>	R.R. Stewart 20635 (RAW).
<i>A. stoliczkae</i>	R.R. Stewart s.n. (RAW).
<i>A. tomentosa</i>	Sadaqat 89 (RAW); R.R. Stewart 20741 (RAW).
<i>A. tridactylites</i>	Wendelbo s.n. (RAW).
<i>Anthemis arvensis</i>	Hassan Din 121 (RAW).
<i>A.cotula</i>	A. Ghafoor & S. Omer 2976 (KUH); Rasool Baksh 73 (KUH); Tahir Ali & Gohar Khan 1A (KUH).
<i>A. odontostephana</i>	S. Abedin 4967 (KUH); Zaffar Ali 4820 (RAW).
<i>A. rhodocentra</i>	A. Ghafoor & Rizwan Yosuf 1405; Zaffar Ali 5702 (RAW).
<i>Chrysanthemum coronarium</i>	Khursheed Anwar s.n. (KUH).
<i>Cotula anthemoides.</i>	Razia Khan 10 (RAW); R.R.Stewart 15870 (RAW)
<i>C. hemisphaerica</i>	P.C. Joshi s.n. (RAW).
<i>Leucanthemum vulgare</i>	S. Abedin 7633 (KUH).
<i>Matricaria aurea</i>	A.A. Qureshi 52 (KUH); Shaukat Ali 26125 (RAW).
<i>M. recutita</i>	Y. Nasir 5055 (KUH); R.R. Stewart 7096 (RAW).
<i>Microcephala lamellate</i>	A. Ghafoor 1352 (KUH); S. Abedin 4794 (KUH); S. Omer & A. Ghafoor 1728 (KUH); A. Ghafoor & Steve M. Goodman 5230 (KUH)
<i>Richteria pyrethroides</i>	David Broadhead 7787 (KUH).
<i>Seriphidium brevifolium</i>	A. Rashid 377 (KUH); R.R. Stewart s.n. (RAW); R.R.Stewart 19283 (RAW)
<i>S.freitagii</i>	A. Ghafoor & S. Omer 1924 (KUH); A. Ghafoor & S. Omer 1974 (KUH);
<i>S. glanduligerum</i>	Vaid Parkash s.n. (RAW).
<i>S. kurramense</i>	S.M.H. Jafri s.n. (KUH); R.R. Stewart s.n. (RAW).
<i>S. leucotrichum</i>	Tahir Ali 2302 (KUH)
<i>S.oliverianum</i>	Mohinder Nath 2020 (RAW).
<i>S. quettense</i>	A. Ghafoor & S. Omer 2169, 2170 (KUH).
<i>S. sieberi</i>	M. Qaiser & A. Ghafoor 4336 (KUH); A. Ghafoor & S. Omer 1984 (KUH).
<i>S. stenocephalum</i>	Jafri 93 (RAW).
<i>S. turanicum</i>	S. Nizamuddin & S. Abedin 637 (KUH); A. Ghafoor & Steve M. Goodman 5235 (KUH); S. Omer & A. Ghafoor 1423 (KUH).
<i>Tanacetopsis afghanica</i>	Haji Rozi Mohammad 12 (RAW).
<i>Tanacetum artemisioides</i>	Kamal A. Malik & S. Nazimuddin 1863 (KUH).
<i>T. baltisticum</i>	R.R. Stewart 26241, 26242 (RAW).
<i>T. chitralense</i>	A. Ghafoor & S. Omer 2712 (KUH); Hassan Din 83 (RAW); Hakim Khan s.n. (RAW).
<i>T. cinerariifolium</i>	Tahir Ali & Gohar Khan s.n. (KUH).
<i>T. falconeri</i>	S. Omer & M. Qaiser 2508 (KUH); R.R. Stewart 26373 (KUH).
<i>T. griffithii</i>	Grohmann 6244 (KUH); Kamal Malik & M. Qaiser 413 (KUH).
<i>T. pakistanicum</i>	Grohmann 6318 (KUH); Nasir & Siddiqui 2926 (KUH).
<i>T. parthenium</i>	Mohinder Nath 2344 (KUH).
<i>Tripleurospermum disciforme</i>	A. Ghafoor & S. Omer 2864 (KUH).
<i>T. parviflorum</i>	Hassan Din 15 (KUH); A. Rehman 25915 (RAW).
<i>Xylanthemum macropodum</i>	S. Omer & A. Ghafoor 1778 (KUH); M. Qaiser 2453; A. Ghafoor & Rizwan Yosuf 1468 (KUH).

**Observations****General cypselas characters of Anthemideae**

Cypselas homomorphic or heteromorphic, oblong, oblanceolate, oblong-oblanceolate, ellipsoid, obconic, obovoid or elliptic-oblong, 0.5-3.5 x 0.25-1 mm, colour varies from yellow to yellowish brown, dark brown, reddish brown or greyish brown; ribbed or non-ribbed, glabrous, glandular or papillate. Pappus absent or present, bristly or scaly, one sided auricle or forming a crown of minute teeth or lacerate scales, off white, golden brown or brown, 0.1-6 mm long. Carpodium absent or present, sub basal, distorted, slightly angular, narrow circular or broad circular disc like, 125-545  $\mu\text{m}$  in diameter. Foramen of carpodium 84-412  $\mu\text{m}$  in diameter (Table 1).

**Key to the genera**

- 1 + Cypselas with 2 reddish brown and abaxial resinous glands at the apices .....  
..... *Tripleurospermum* 2
- Cypselas without such glands ..... 2
- 2 + Cypselas epappose ..... 3
- Cypselas pappose ..... 9
- 3 + Cypselas homomorphic and wingless ..... 4
- Cypselas heteromorphic and winged ..... 8
- 4 + Carpodium distorted ..... *Leucanthemum*
- Carpodium circular or not developed ..... 5
- 5 + Cypselas 0.5–1.0 mm long ..... *Seriphidium, Matricaria*
- Cypselas 1.5–3.0 mm long ..... 6
- 6 + Carpodium not developed ..... *Anthemis*
- Carpodium well developed ..... 7
- 7 + Cypselas obovoid-oblanceolate. Carpodium broad circular disc like, 159  $\mu\text{m}$  in diameter ..... *Ajania*
- Cypselas oblong or oblong-oblanceolate. Carpodium narrow circular ring or 4-6 lobed ring, 200-246  $\mu\text{m}$  in diameter ..... *Achillea*
- 8 + Cypselas slightly ribbed, 2.5-3.0 mm long ..... *Chrysanthemum*
- Cypselas non ribbed, 1-1.5 mm long ..... *Cotula*
- 9 + Pappus bristly ..... *Allardia*
- Pappus scaly forming an auricle or short crown ..... 10
- 10 + Carpodium not developed ..... *Anthemis*
- Carpodium well developed ..... 11

- 11 + Pappus of one sided auricle ..... *Xylanthemum*  
 - Pappus crowned by scarious, lacerate or minutely toothed scales ..... 12
- 12 + Cypselas monomorphic, all pappose ..... 13  
 - Cypselas dimorphic, atleast of disc epappose ..... *Matricaria*
- 13 + Carpopodium distorted ..... *Richteria*  
 - Carpopodium circular or angular ..... 14
- 14 + Cypselas ventrally-3-5 ribbed ..... *Microcephala*  
 - Cypselas entirely 5-8 ribbed ..... *Tanacetopsis, Tanacetum*

### *Achillea* L.

It is represented by 4 species *i.e.*, *A. filipendulina* Lam., *A. millefolium* L., *A. setacea* Waldst. & Kit., and *A. wilhelmsii* C. Koch.

Cypselas oblong or oblong-ob lanceolate, 1.5-2x0.75-1.0 mm, light brown or yellowish brown, non-ribbed or 8-12-ribbed, glabrous. Pappus absent. Carpopodium 4-6 lobed ring or narrow circular ring without any interruption, 200-246  $\mu\text{m}$  in diameter. Foramen of carpopodium 122-198  $\mu\text{m}$  in diameter (Table 1; Fig. 1A-F).

#### Key to the species of *Achillea*

- 1 + Cypselas non-ribbed. Carpopodium with 4-6 lobed ring ..... *A. wilhelmsii*  
 - Cypselas ribbed. Carpopodium with circular ring ..... 2
- 2 + Cypselas yellowish-brown, 10-12 ribbed ..... *A. millefolium*  
 - Cypselas light brown, 8-10 ribbed ..... *A. filipendulina, A. setacea*

### *Ajania* Poljakov

It is represented by single species *viz.*, *A. fruticulosa* (Ledeb.) Poljakov

Cypselas obovoid-ob lanceolate, 2x0.75 mm, brown, 10-12 ribbed, glabrous. Pappus absent. Carpopodium broad circular ring without any interruption, 159  $\mu\text{m}$  in diameter. Foramen of carpopodium 88  $\mu\text{m}$  in diameter (Table 1; Fig. 1G-I).

### *Allardia* Decne.

It comprises 5 species *i.e.*, *A. glabra* Decne., *A. nivea* Hook. f. & Thomson ex C.B. Clarke, *A. stoliczkae* C.B. Clarke, *A. tomentosa* Decne., and *A. tridactylites* (Kar.&Kir) Schultz- Bip.

Cypselas oblong, 2-2.5x0.5-1 mm, yellowish-dark brown, non ribbed or 6-8 ribbed, glabrous or papillate or glabrous-papillate. Pappus uniseriate, bristly, barbellate or scabrid, golden brown, bristles 22-60, 3-4 mm long. Carpopodium narrow or broad circular or angular without any interruption, 355-545  $\mu\text{m}$  in diameter. Foramen of carpopodium 205 -412  $\mu\text{m}$  in diameter (Table 1; Figs. 1J-O; 2A-I)

Table 1. Cypselia morphological features in the tribe Anthemideae

Name of taxa	Cypselia		
	Shape	Colour	Surface
<i>Achillea filipendulina</i>	Oblong	Light brown	8-10-ribbed, glabrous
<i>A. millefolium</i> subsp. <i>millefolium</i>	Oblong	Yellowish brown	10-12-ribbed, glabrous
<i>A. setacea</i>	Oblong	Light brown	8-10-ribbed, glabrous
<i>A. wilhelmsii</i>	Oblong-ob lanceolate	Yellowish brown	Non-ribbed, glabrous
<i>Ajania fruticulosa</i>	Oblanceolate-obovoid	Brown	10-12-ribbed, glabrous
<i>Allardia glabra</i>	Oblong	Yellowish brown	Non-ribbed, glabrous
<i>A. nivea</i>	Oblong	Yellowish brown	6-8-ribbed, papillate
<i>A. stoliczkae</i>	Oblong	Dark brown	6-8-ribbed, glabrous
<i>A. tomentosa</i>	Oblong	Yellowish brown	6-8-ribbed, glabrous-papillate
<i>A. tridactylites</i>	Oblong	Yellowish brown	Non-ribbed, sparsely papillate
<i>Anthemis arvensis</i>	Obconical, 4-angled	Yellowish brown	8-10-ribbed, glabrous
<i>A. cotula</i>	Obconical, slightly angular	Yellowish brown	8-10-ribbed, tuberculate
<i>A. odontostephana</i>	Oblong-ob lanceolate	Greyish black	10-12-ribbed, tuberculate-muricate
<i>A. rhodocentra</i>	Oblong-ob lanceolate	Greyish black	8-ribbed, glabrous
<i>Chrysanthemum coronarium</i>	Oblanceolate: Ray cypselia winged, disc unwinged	Reddish brown	Slightly ribbed, sessile glandular
<i>Cotula anthemoides</i>	Ovate, narrowly winged	Yellowish brown	Non-ribbed, papillose
<i>C. hemisphaerica</i>	Oblong-ovate: Ray cypselia narrowly winged, disc unwinged	Reddish brown	Non-ribbed, sessile glandular
<i>Leucanthemum vulgare</i>	Oblanceolate	Dark brown	8-10-ribbed, glabrous
<i>Matricaria aurea</i>	Oblong	Yellowish brown	8-10-ribbed, glabrous
<i>M. recutita</i>	Oblong-obconical	Dark brown	5-6-ribbed, glabrous or with sessile glands
<i>Microcephala lamellata</i>	Oblanceolate	Yellowish brown	Ventrally 3-5-ribbed, dense mucilaginous hairs with myxogenic twin hairs
<i>Richeria pyrethroides</i>	Oblong-ob lanceolate	Dark brown	6-8-ribbed, sparsely papillate
			Size (mm)
			1.5 x 0.75
			2.0 x 1.0
			2.0 x 1.0
			2.0 x 1.0
			2.0 x 0.75
			2.5 x 1.0
			2.0 x 1.0
			2.0 x 0.5
			2-2.5 x 0.5-1.0
			2.0 x 0.5
			2.0 x 1.0
			2.0 x 1.0
			3.0 x 1.0
			2.5 x 1.0
			2.5-3.0 x 1.5
			1.5 x 0.75
			1-1.5 x 0.75-1.0
			1.5 x 0.75
			1.0 x 0.5
			1.5-2.5 x 0.5-1.0
			1.5 x 0.5
			2-2.5 x 0.75

Table 1. (Cont'd.).

Name of taxa	Cypselae		
	Shape	Colour	Surface
<i>Seriphidium brevifolium</i>	Ellipsoid	Yellowish brown	6-8-ribbed, glabrous
<i>S. freitagii</i>	Oblong-oblanccolate	Yellowish brown	8-10-ribbed, glabrous
<i>S. glanduligerum</i>	Ellipsoid	Yellowish brown	8-10-ribbed, glabrous
<i>S. kurramense</i>	Oblanccolate	Yellowish brown	10-12-ribbed, glabrous
<i>S. leucoctricum</i>	Oblanccolate	Yellowish brown	10-12-ribbed, glabrous
<i>S. oliverianum</i>	Oblanccolate	Dark brown	12-16-ribbed, glabrous
<i>S. quellense</i>	Oblanccolate	Dark brown	12-16-ribbed, glabrous
<i>S. sieberi</i>	Oblanccolate	Yellowish brown	12-16-ribbed, glabrous
<i>S. stenocephalum</i>	Obovoid	Dark brown	10-12-ribbed, glabrous
<i>S. turanicum</i>	Ellipsoid	Dark brown	12-16-ribbed, glabrous
<i>Tanacetopsis affghanica</i>	Oblong	Yellowish brown	5-ribbed, sessile glandular
<i>Tanacetum artemisioides</i>	Oblong-oblanccolate	Yellowish brown	5-6 ribbed, glabrous
<i>T. balistanicum</i>	Oblanccolate	Yellowish brown	5-6- ribbed, glabrous
<i>T. chitralense</i>	Oblong	Yellowish brown	4-ribbed, papillate in between the ribs
<i>T. cinerariifolium</i>	Oblong-oblanccolate	Yellowish brown	5-ribbed, glabrous
<i>T. falconeri</i>	Oblong-oblanccolate	Greyish brown	6-8-ribbed, glandular
<i>T. griffithii</i>	Oblong-oblanccolate	Yellowish brown	6-8-ribbed papillate in b/w the ribs
<i>T. pakistanicum</i>	Oblanccolate	Yellowish brown	5-ribbed, papillate in b/w the ribs
<i>T. parthenium</i>	Oblong	Greyish brown	6-8-ribbed, densely glandular in b/w the ribs
<i>Tripleurospermum disciforme</i>	Oblong-oblanccolate	Yellow	Ventrally 3-ribbed, dorsally 2-ribbed, glabrous with two apical glands
<i>T. parviflorum</i>	Oblong	Reddish brown	Ventrally 3-ribbed, dorsally 2-ribbed, tuberculate with two apical glands
<i>Xylanthemum macropodium</i>	Elliptic-oblong	Yellow	5-6-ribbed, glabrous

Table 1. (Cont'd.).

Name of taxa	Pappus			
	Structure	Number	Length (mm)	Colour
<i>Achillea filipendulina</i>	-	-	-	-
<i>A. millefolium</i> subsp. <i>millefolium</i>	-	-	-	-
<i>A. setacea</i>	-	-	-	-
<i>A. wilhelmsii</i>	-	-	-	-
<i>Ajania fruticulosa</i>	-	-	-	-
<i>Allardia glabra</i>	Uniseriate, barbellate bristles	22-24	4.0	Golden brown
<i>A. nivea</i>	Uniseriate, scabrid bristles	45-60	4.0	Golden brown
<i>A. stoliczkae</i>	Uniseriate, scabrid bristles	40-45	3.0	Golden brown
<i>A. tomentosa</i>	Uniseriate, scabrid bristles	28-32	3-4	Golden brown
<i>A. tridactylites</i>	Uniseriate, scabrid bristles	28-40	5-6	Golden brown
<i>Anthemis arvensis</i>	Short, thickened undulating rim	-	-	Golden brown
<i>A. cotula</i>	-	-	-	-
<i>A. odontostephana</i>	Short slightly dentate rim	-	-	Golden brown
<i>A. rhodocentra</i>	-	-	-	-
<i>Chrysanthemum coronarium</i>	-	-	-	-
<i>Cotula anthemoides</i>	-	-	-	-
<i>C. hemisphaerica</i>	-	-	-	-
<i>Leucanthemum vulgare</i>	Ray cypselae: one-sided auricled, disc cypselae: epappose	-	0.3-0.5	Off white
<i>Matricaria aurea</i>	-	-	-	-
<i>M. recutita</i>	Ray cypselae: membranous auricled, disc cypselae: epappose	-	1.0	Off white
<i>Microcephala lamellata</i>	Lacerate scales	6-10	0.75	Off white
<i>Richeria pyrethroides</i>	Corona of dissected scales	6-9	0.75	Off white

Table 1. (Cont'd.).

Name of taxa	Pappus			Colour
	Structure	Number	Length (mm)	
<i>Seriphidium brevifolium</i>	-	-	-	-
<i>S. freitagii</i>	-	-	-	-
<i>S. glauduligerum</i>	-	-	-	-
<i>S. kurrumense</i>	-	-	-	-
<i>S. leucotrichum</i>	-	-	-	-
<i>S. oliverianum</i>	-	-	-	-
<i>S. quettense</i>	-	-	-	-
<i>S. sieberi</i>	-	-	-	-
<i>S. stenocephalum</i>	-	-	-	-
<i>S. turanicum</i>	-	-	-	-
<i>Tanacetopsis afghanica</i>	Corona of lacerate scales	-	0.5	Off white
<i>Tanacetum artemisioides</i>	Corona of scaly teeth	-	0.1-0.2	Yellowish- brown
<i>T. baltistanicum</i>	Minutely toothed corona	-	0.2	Off white
<i>T. chitralense</i>	Corona of lacerate scales	-	1.0	Off white
<i>T. cinerarifolium</i>	Corona of lacerate scales	-	1.0	Off white
<i>T. falconeri</i>	Corona of lacerate scales	-	0.5	Off white
<i>T. griffithii</i>	Corona of lacerate scales	-	1.0	Off white
<i>T. pakistanicum</i>	Minutely toothed corona	-	0.2	Off white
<i>T. parthenium</i>	Minutely toothed corona	-	0.2	Off white
<i>Tripleurospermum disciforme</i>	-	-	-	-
<i>T. parviflorum</i>	Corona of scarious scales	-	0.75	Brown
<i>Xylanthemum macropodium</i>	One sided entire auricle	-	1.0	Off white

Table 1. (Cont'd.)

Name of taxa	Carpopodium			
	Shape	Position	Diameter of carpopodium ( $\mu\text{m}$ )	Diameter of foramen of carpopodium ( $\mu\text{m}$ )
<i>Achillea filipendulina</i>	Narrow circular ring without any interruption	subbasal	210	140
<i>A. millefolium</i> subsp. <i>millefolium</i>	Narrow circular ring without any interruption	subbasal	240	198
<i>A. setacea</i>	Narrow circular ring without any interruption	subbasal	200	198
<i>A. wilhelmsii</i>	Ring with 4-6 lobes, without any interruption	subbasal	246	122
<i>Ajania fruticulosa</i>	Broad circular ring without any interruption	subbasal	159	88
<i>Allardia glabra</i>	Narrow circular ring without any interruption	subbasal	384	205
<i>A. nivea</i>	Slightly angular, broad disc without any interruption	subbasal	400	260
<i>A. stoliczkae</i>	Slightly angular, broad disc without any interruption	subbasal	355	230
<i>A. tomentosa</i>	Narrow angular ring without any interruption	subbasal	545	412
<i>A. tridactylites</i>	Narrow circular ring, without any interruption	subbasal	480	375
<i>Anthemis arvensis</i>	Not developed	-	-	-
<i>A. cotula</i>	Not developed	-	-	-
<i>A. odontostephana</i>	Not developed	-	-	-
<i>A. rhodocentra</i>	Not developed	-	-	-
<i>Chrysanthemum coronarium</i>	Not developed	-	-	-
<i>Cotula anthemoides</i>	Not developed	-	-	-
<i>C. hemisphaerica</i>	Not developed	-	-	-
<i>Leucanthemum vulgare</i>	Distorted	subbasal	275	170
<i>Matricaria aurea</i>	Narrow circular ring without any interruption	subbasal	145	110
<i>M. rectita</i>	Narrow circular ring without any interruption	subbasal	348	268
<i>Microcephala lamellata</i>	Broad circular ring without any interruption	subbasal	207	116
<i>Richeria pyrethroides</i>	Distorted	subbasal	390	310

Table 1. (Cont'd.)

Name of taxa	Carpopodium			Diameter of foramen of carpopodium (µm)
	Shape	Position	Diameter of carpopodium (µm)	
<i>Seriphidium brevifolium</i>	Not developed	-	-	-
<i>S. freitagii</i>	Not developed	-	-	-
<i>S. glanduligerum</i>	Not developed	-	-	-
<i>S. karramense</i>	Not developed	-	-	-
<i>S. leucotrichum</i>	Not developed	-	-	-
<i>S. oliverianum</i>	Broad circular ring without any interruption	subbasal	140	95
<i>S. quettense</i>	Broad circular ring without any interruption	subbasal	149	109
<i>S. sieberi</i>	Broad circular ring without any interruption	subbasal	134	87
<i>S. stenocephalum</i>	Narrow circular ring without any interruption	subbasal	229	176
<i>S. turanicum</i>	Broad circular ring without any interruption	subbasal	125	84
<i>Tanacetopsis afghanica</i>	Broad circular ring without any interruption	subbasal	150	109
<i>Tanacetum artemisioides</i>	Broad circular ring without any interruption	subbasal	160	104
<i>T. ballistanicum</i>	Slightly angular ring without any interruption	subbasal	240	145
<i>T. chitralense</i>	Slightly angular ring without any interruption	subbasal	285	210
<i>T. cinerariifolium</i>	Broad circular ring without any interruption	subbasal	275	193
<i>T. falconeri</i>	Slightly angular ring without any interruption	subbasal	254	187
<i>T. griffithii</i>	Slightly angular ring without any interruption	subbasal	326	240
<i>T. pakistanicum</i>	Slightly angular ring without any interruption	subbasal	305	196
<i>T. parthenium</i>	Slightly angular ring without any interruption	subbasal	191	136
<i>Tripleurospermum disciforme</i>	Broad circular disc without any interruption	subbasal	183	127
<i>T. parviflorum</i>	Broad circular disc without any interruption	subbasal	192	122
<i>Xylanthemum macropodium</i>	Broad circular disc without any interruption	subbasal	380	290

Fig. 1. Scanning Electron Micrographs. *Achillea millifolium*: A, cypsel; B, surface; C, carpodium. *A. wilhelmsii*: D, cypsel; E, surface; F, carpodium. *Ajania fruticulosa*: G, cypsel; H, surface; I, carpodium. *Allardia glabra*: J, cypsel; K, surface; L, carpodium. *A. nivea*: M, cypsel; N, surface ; O, carpodium (undeveloped) (scale bar: A,D,G,J,M=200 $\mu$ m; B,C,E,F,H,I,K,L,N,O=50 $\mu$ m).

Fig. 2. Scanning Electron Micrographs. *Allardia stoliczkae*: A, cypsela; B, surface; C, carpodium. *A. tomentosa*: D, cypsela; E, surface; F, carpodium. *A. tridactylites*: G, cypsela; H, surface; I, carpodium. *Anthemis arvensis*: J, cypsela; K, surface; L, carpodium (undeveloped). *A. cotula*: M, cypsela; N, surface ; O, carpodium (undeveloped) (scale bar: A,D,G,J,M=200 $\mu$ m;B,E,K=20 $\mu$ m;C,H,I,O=50  $\mu$ m ; F,N,L=100 $\mu$ m)

**Key to the species of *Allardia***

- 1 + Cypselas non-ribbed ..... 2  
 - Cypselas 6-8 ribbed ..... 3
- 2 + Cypselas glabrous. Pappus bristles 4 mm long ..... *A. glabra*  
 - Cypselas sparsely papillate. Pappus bristles 5-6 mm long ..... *A. tridactyliles*
- 3 + Cypselas papillate ..... *A. nivea*  
 - Cypselas glabrous ..... 4
- 4 + Carpopodium broad circular disc like, 355µm in diameter ..... *A. stoliczkae*  
 Carpopodium narrow angular ring like, 545µm in diameter ..... *A. tomentosa*

***Anthemis* L.**

It is represented by 4 species viz., *A. arvensis* L., *A. cotula* L., *A. odontostephana* Boiss., and *A. rhodocentra* Iranshahr.

Cypselas angular or non-angular, obconical or oblong-ob lanceolate, 2-3x1 mm, 8-10 ribbed, glabrous, tuberculate or tuberculate-muricate. Pappus short, undulating or dentate rim. Carpopodium not developed (Table 1; Figs. 2J-O; 3A-F).

**Key to the species of *Anthemis***

- 1 + Cypselas obconical, angular and yellowish brown ..... 2  
 - Cypselas oblong-ob lanceolate, non-angular and greyish black ..... 3
- 2 + Cypselas glabrous. Pappus short, thickened, forming an undulating rim .....  
 ..... *A. arvensis*  
 - Cypselas tuberculate. Pappus absent ..... *A. cotula*
- 3 + Cypselas tuberculate-muricate. Pappus short, slightly dentate rim .....  
 ..... *A. odontostephana*  
 - Cypselas glabrous. Pappus absent ..... *A. rhodocentra*

***Chrysanthemum* L.**

It comprises single species i.e., *C. coronarium* L.

Cypselas heteromorphic, oblanceolate; ray cypselas triquetrous, winged; disc cypselas laterally flattened, unwinged with small spine-like appendages at the rim, 2.5-3x1.5mm, reddish brown, slightly ribbed, glandular. Pappus absent. Carpopodium not developed (Table 1; Figs. 3G-I).

***Cotula* L.**

It is represented by 2 species i.e., *C. anthemoides* L., and *C. hemisphaerica* (Roxb.) Wall. ex Benth. & Hook. f.

Fig. 3. Scanning Electron Micrographs. *Anthemis odontostephana*: A, cypsela; B, surface; C, carpodium (undeveloped). *A. rhodocentra*: D, cypsela; E, surface; F, carpodium (undeveloped). *Chrysanthemum coronarium* (Disc floret): G, cypsela; H, surface; I, carpodium (undeveloped). *Cotula anthemoides*: J, cypsela; K, surface; L, carpodium (undeveloped). *A. hemisphaerica*: M, cypsela; N, surface; O, carpodium (undeveloped) (scale bar: A,J =200µm; B,C,F,H,I,L,M=100µm; D,G=500µm; E,K,N =50µm; O=10µm).

Fig. 4. Scanning Electron Micrographs. *Leucanthemum vulgare* (Disc floret ): A, cypsela; B, surface ; C, carpodium. *Matricaria aurea*: D, cypsela; E, surface; F, carpodium. *M. recutita* (Ray floret): G, cypsela; H, surface; I, carpodium. *Microcephala lamellata*: J, cypsela; K, surface; L, carpodium. *Richteria pyrethroides*: M, cypsela; N, surface; O, carpodium (undeveloped) (scale bar: A,G,J=200 $\mu$ m; B=5 $\mu$ m; C,N,O=50 $\mu$ m; D=100 $\mu$ m; E,H=10 $\mu$ m; F,I,K,L=20 $\mu$ m; M=500  $\mu$ m).

Cypselas heteromorphic, ovate or oblong-ovate, winged or unwinged, 1-1.5x0.75-1mm, yellowish or reddish brown, non-ribbed, glabrous or sessile glandular. Pappus absent. Carpodium not developed (Table 1; Fig. 3J-O).

#### Key to the species of *Cotula*

- 1 + Cypselas yellowish brown and monomorphic ..... *C. anthemoides*
- Cypselas reddish brown and dimorphic ..... *C. hemisphaerica*

#### *Leucanthemum* Miller

It comprises single species viz., *L. vulgare* Lam.

Cypselas heteromorphic, oblanceolate, 1.5x0.75 mm, dark brown, 8-10-ribbed, glabrous. Ray cypselas with one sided auricle, 0.3-0.5 mm, off white pappus; disc cypselas epappose. Carpodium distorted, 275µm in diameter. Foramen of carpodium 170 µm in diameter (Table 1; Fig. 4A-C).

#### *Matricaria* L.

It comprises 2 species i.e., *M. aurea* (Loefl.) Schultz-Bip., and *M. recutita* L.

Cypselas monomorphic or dimorphic, oblong, oblong-oblanceolate 1-2.5x0.25-1mm, yellowish brown or dark brown, 5-10- ribbed, glabrous or with sessile glands. Pappus absent or only ray cypselas with one sided auricle, offwhite, 0.3-0.5mm. Carpodium narrow circular ring without any interruption, 145-338µm in diameter. Foramen of carpodium 110-268µm in diameter (Table 1; Fig. 4D-I)

#### Key to the species of *Matricaria*

- 1 + Cypselas monomorphic, epappose. Carpodium 145µm in diameter ..... *M. aurea*
- Cypselas dimorphic outer ones with membranous auricled pappus; inner ones epappose. Carpodium 348µm in diameter ..... *M. recutita*

#### *Microcephala* Pobed.

It is represented by single species viz., *M. lamellata* (Bunge) Pobed.

Cypselas oblanceolate, 1.5x0.5, yellowish brown, ventrally 3.5-ribbed, dense mucilaginous hairs with myxogenic twin hairs. Pappus of lacerate scales, offwhite, 6-10 in number, 0.75mm long. Carpodium broad circular ring without any interruption, 207µm in diameter. Foramen of carpodium 116µm in diameter (Table 1; Fig. 4J-L).

#### *Richteria* Kar. & Kir.

It comprises single species i.e., *R. pyrethroides* Kar. & Kir.

Cypselas oblong-oblanceolate, 2-2.5x0.75mm, dark brown, 6-8 ribbed, sparsely papillate. Pappus forming corona of dissected scales, off white, 6-9 in number, 0.75 mm long. Carpodium distorted, 390µm in diameter. Foramen of carpodium 310µm in diameter (Table 1; Fig. 4M-O).

***Seriphidium*** (Besser ex Hook.) Fourr.

It is represented by 10 species *i.e.*, *S. brevifolium* (Wall. ex DC.) Ling & Y.R. Ling, *S. freitagii* (Podl.) Y.R. Ling, *S. glanduligerum* (Krasch. ex Poljakov) Poljakov, *S. kurramense* (Qazilb.) Y.R. Ling, *S. leucotrichum* (H. Krasch ex. Ladyg.) K. Bremer & Humphries ex Y.R. Ling, *S. oliverianum* (J. Gray ex Besser) K. Bremer & Humphries ex Y.R. Ling, *S. quettense* (Podl.) Ling, *S. sieberi* (Besser) K. Bremer & Humphries ex Y.R. Ling, *S. stenocephalum* (Krasch. ex Poljakov) Poljakov and *S. turanicum* (Krasch.) Poljakov.

Cypselas oblong-oblancheolate, oblancheolate, ellipsoid or obovoid, 0.5-1.0x2.5-0.5mm, yellowish brown or dark brown, 6-16-ribbed, glabrous. Pappus absent. Carpopodium absent or narrow-broad circular ring without any interruption, 125-229µm in diameter (Table 1; Figs. 5A-O; 6A-F).

**Key to the species of *Seriphidium***

- 1 + Carpopodium not developed ..... 2
  - Carpopodium narrow circular or broad disc like ..... 4
- 2 + Cypselas ellipsoid ..... *S. brevifolium*
  - Cypselas oblancheolate or oblong-oblancheolate ..... 3
- 3 + Cypselas oblong-oblancheolate, 0.5x0.25 mm ..... *S. freitagii*
  - Cypselas oblancheolate, 10-12 ribbed, 1.0x0.5 mm ... *S. kurramense*, *S. leucotrichum*
- 4 + Cypselas obovoid. Carpopodium narrow circular ring ..... *S. stenocephalum*
  - Cypselas ellipsoid or oblancheolate. Carpopodium broad circular disc ..... 5
- 5 + Cypselas ellipsoid ..... *S. turanicum*
  - Cypselas oblancheolate ..... 6
- 6 + Cypselas dark brown ..... *S. quettense*, *S. oliverianum*
  - Cypselas yellowish brown ..... *S. sieberi*

***Tanacetopsis*** (Tzvelev) Kovalevsk.

It comprises single species *i.e.*, *T. afghanica* (Gilli) K. Bremer & Humphries.

Cypselas oblong, 2-2.5x0.25-0.5 mm, yellowish brown, 5-ribbed, sessile glandular. Pappus forming a crown of lacerate scale, off-white, 0.5mm long. Carpopodium broad circular disc like without any interruption, 150µm in diameter. Foramen of carpopodium 109 µm in diameter (Table 1; Fig. 6G-I).

***Tanacetum*** L.

It is represented by 8 species *i.e.*, *T. artemisioides* Schulz-Bip. ex Hook. f., *T. baltistanicum* Podlech, *T. chitralense* (Podl.) K. Bremer & Humphries, *T. cinerariifolium* (Trevir) Schultz-Bip., *T. falconeri* Hook. f., *T. griffithii* (C.B. Clarke) Muradyan, *T. pakistanicum* Podl. and *T. parthenium* (L.) Schultz-Bip.

Fig. 5. Scanning Electron Micrographs. *Seriphidium kurramense*: A, cypsela; B, surface; C, carpodium (Undeveloped). *S. leucotrichum*: D, cypsela; E, surface; F, carpodium (Undeveloped). *S. oliverianum*: G, cypsela; H, surface; I, carpodium. *S. quettense*: J, cypsela; K, surface; L, carpodium. *S. sieberi*: M, cypsela; N, surface; O, carpodium (scale bar: A,D,G,J,M=100 $\mu$ m B,E,F,H,L,N,O=20 $\mu$ m; C,K=10 $\mu$ m ;I=50 $\mu$ m).

Fig. 6. Scanning Electron Micrographs. *S. stenocephalum*: A, cypsela; B, surface; C, carpodium .  
*S. turanicum*: D, cypsela; E, surface; F, carpodium. *Tanacetopsis afghanica*: G, cypsela;. H,  
surface; I, carpodium. *Tanacetum artemisioides*: J, cypsela; K, surface; L, carpodium. *T.*  
*chitralense* : M, cypsela; N, surface ; O, carpodium (scale bar: A,D=100 $\mu$ m G,J,M= 200 $\mu$ m ;  
E,F,H,I,K=20 $\mu$ m ; C,L,N,O= 50 $\mu$ m).

Cypselas oblong, oblanceolate or oblong-oblanceolate, 1.5-3.5x0.5-1mm, yellowish brown or greyish brown, 4-8-ribbed, glabrous, glandular or papillate. Pappus a crown of minute teeth or lacerate scale, off-white, 0.1-1mm long. Carpodium slightly angular or broad circular without any interruption, 160-326 $\mu$ m in diameter. Foramen of carpodium 104-240 $\mu$ m in diameter (Table 1; Figs. 6J-O; 7A-O).

#### Key to the species of *Tanacetum*

- 1 + Cypselas glabrous ..... 1
- Cypselas papillate or glandular ..... 4
- 2 + Carpodium broad circular disc like ..... *T. cinerariifolium*
- Carpodium slightly angular ring like ..... 3
- 3 + Cypselas oblanceolate. Carpodium 240  $\mu$ m in diameter ..... *T. baltistanicum*
- Cypselas oblong-oblanceolate. Carpodium 160 $\mu$ m in diameter ..... *T. artemesioides*
- 4 + Cypselas 4 ribbed ..... *T. chitralense*
- Cypselas 5-8 ribbed ..... 5
- 5 + Cypselas greyish-brown ..... 6
- Cypselas yellowish brown ..... 7
- 6 + Pappus with a crown of lacerate scales ..... *T. falconeri*
- Pappus with a minutely toothed corona ..... *T. parthenium*
- 7 + Cypselas 6-8 ribbed. Pappus 1.0 mm long ..... *T. griffithii*
- Cypselas 5-ribbed. Pappus 0.2 mm long ..... *T. pakistanicum*

#### *Tripleurospermum* Schiltz-Bip.

It is represented by two species *i.e.*, *T. disciforme* (C.A. Mey) Schultz-Bip., and *T. parviflorum* (Willd.) Pobed.

Cypselas oblong or oblong-oblanceolate, 1.5-2x0.5-1mm, yellow or reddish brown, apically with 2 reddish-brown glands, ventrally 3-ribbed, dorsally 2-ribbed, glabrous or tuberculate. Pappus absent or crowned with scarious scales, brown, 0.75mm. Carpodium broad circular disc without any interruption, 183-192 $\mu$ m in diameter. Foramen of carpodium 122-127 $\mu$ m in diameter (Table 1; Fig. 8A-F).

#### Key to the species of *Tripleurospermum*

- 1 + Cypselas yellow. Pappus absent ..... *T. disciforme*
- Cypselas reddish-brown. Pappus with a crown of scarious scales ..... *T. parviflorum*

#### *Xylanthemum* Tzvelev

It is represented by a single species *i.e.*, *X. macropodium* (Hemsl. & Lace) K. Bremer & Humphries.

Fig. 7. Scanning Electron Micrographs. *Tanacetum cinerariifolium*: A, cypsela; B, surface; C, carpodium. *T. falconeri*: D, cypsela; E, surface; F, carpodium. *T. griffithii*: G, cypsela; H, surface; I, carpodium. *T. pakistanicum*: J, cypsela; K, surface; L, carpodium. *T. parthenium*: M, cypsela; N, surface; O, carpodium (scale bar: A,G=500  $\mu\text{m}$ ; D,J,M=200 $\mu\text{m}$ ; B,E,O= 20 $\mu\text{m}$ ; K=100 $\mu\text{m}$ ; C,F,H,I,L,N=50 $\mu\text{m}$ ).

Fig. 8. Scanning Electron Micrographs. *Tripleurospermum disciforme*: A, cypsela; B, surface; C, carpopodium. *T. parviflorum*: D, cypsela; E, surface; F, carpopodium. *Xylanthemum macropodium*: G, cypsela; H, surface; I, carpopodium. (scale bar: A,D,G=200 $\mu$ m ; B,C,F,H= 20 $\mu$ m; E,I=50 $\mu$ m ).

Cypselas elliptic-oblong, 1.5-2.5x0.75-1mm, yellow, 5-6-ribbed, glabrous. Pappus forming one sided entire auricle, off white, 1mm long. Carpopodium broad circular disc like without any interruption, 380 $\mu$ m in diameter. Foramen of capopodium 290 $\mu$ m in diameter (Table 1; Fig. 8G-I).

### Results and Discussion

The tribes Inuleae, Heliantheae and Eupatoreae of the family Asteraceae are characterized due to their cypsela features (Bremer, 1994; Qaiser & Abid, 2003). However, similar to those of tribes Plucheeae and Gnaphalieae (Abid & Qaiser, 2007b, 2008b) Anthemideae does not have characteristic cypsela. Although on the basis of cypsela morphology 44 species distributed in 15 genera of the tribe Anthemideae could be recognized from Pakistan (Table 1; Figs. 1-8).

All the genera of the Anthemideae can be divided into two main groups on the basis of pappose or epappose cypsela except that of the three genera *viz.*, *Anthemis*, *Matricaria* and *Tripleurospermum* where both the pappose and epappose cypselas are found so these genera are discussed in both the groups. Besides this, *Tripleurospermum* is the only genus which has two abaxial resinous glands towards the cypsela apices (Ghafoor, 2002).

Group of epappose cypselas includes *Achillea*, *Ajania*, *Anthemis* (p.p.), *Chrysanthemum*, *Cotula*, *Leucanthemum*, *Matricaria* (p.p.), *Seriphidium* and *Tripleurospermum* (p.p.). From these *Chrysanthemum*, *Cotula* and *Leucanthemum* are grouped together due to the winged and heteromorphic cypselas and *Leucanthemum* further remains distinct by the presence of distorted carpodium. While in *Chrysanthemum* and *Cotula*, carpodium does not develop and both the genera could be separated with each other by having ribbed or non-ribbed cypselas respectively. Another sub-group of epappose genera including *Achillea*, *Ajania*, *Matricaria*, *Seriphidium* and *Tripleurospermum*, is characterized by homomorphic and unwinged cypselas. Within this *Seriphidium* is distinguished due to smaller cypselas. *Ajania* remains distinct from *Achillea* and *Matricaria* by the presence of broad circular disc like carpodium while in the above two genera carpodium is narrow circular or 4-6-lobed ring like but still these two genera are distinguished by having smaller cypselas in *Matricaria* as compared to *Achillea*. Similarly, the genus *Anthemis* is characterized by the absence of carpodium and long sized cypselas. The second group of genera with pappose cypselas comprises *Allardia*, *Anthemis* (p.p.), *Matricaria* (p.p.), *Microcephala*, *Richteria*, *Tanacetum*, *Tanacetopsis*, *Tripleurospermum* (p.p.) and *Xylanthemum*. Amongst these genera *Allardia* is characterized by bristly pappus while in rest of the genera scaly pappus forming an auricle or short crown. Similarly, *Xylanthemum* is distinguished by the presence of one-sided auricled pappus and in other genera pappus is coronate. On the other hand *Matricaria* species have dimorphic cypselas with atleast epappose disc cypselas while in remaining genera cypselas are monomorphic. *Anthemis* remains distinct due to the absence of carpodium. Like wise, *Richteria* is characterized by the presence of distorted carpodium but the other genera are characterized by circular or angular carpodium. Amongst the remaining three genera, *Microcephala* is characterized by the presence of 3-5 ribs on only ventral side while in *Tanacetum* and *Tanacetopsis*, ribs are all sided and both of the genera could not be separated from each other due to indistinct cypselas.

Similar to that of generic delimitation, cypselas features may also be utilized for specific delimitation as the species of *Achillea* are grouped on the basis of ribbed and non-ribbed cypselas. *A. millefolium* is characterized by yellowish-brown and 10-12 ribbed cypselas while light brown and 8-10 ribbed cypselas are found in *A. filipendulina* and *A. setacea*. While non-ribbed cypselas are characteristic for *A. wilhelmsii*. Similarly, in the genus *Allardia* species may also be separated on the basis of ribbed or non-ribbed cypselas. Within the group of non-ribbed cypselas *A. glabra* and *A. tridactylites* are distinguished respectively by having glabrous and papillate cypselas. On the other hand group of ribbed cypselas is further divided by having papillate cypselas in *A. nivea* and glabrous cypselas in *A. stoliczkae* and *A. tomentosa* but both the species remain distinct due to the different shapes and diameter of carpodium. Species of another genus *Anthemis* may also be divided into two groups by having greyish black and terete cypselas. While another group is characterized by angular and yellowish brown cypselas. The first group including *A. odontostephana* and *A. rhodocentra*, and both the species remain distinct by the presence of tuberculate and pappose cypselas and glabrous cypselas without pappus respectively. Similarly the species of *Cotula* are distinguished due to the colour of cypselas. Likewise, the species of the genera *Matricaria* and *Tripleurospermum* could be separated by the presence or absence of pappus. Within the genus *Seriphidium* all the species are grouped by the presence or absence of carpodium taxa where carpodium is absent including *S. brevifolium*, *S. glanduligerum*, *S. freitagii*,

*S. kurramense* and *S. leucotrichum* from which two of the first species are grouped by the presence of ellipsoid cypsels while in remaining species cypsels are oblanceolate or oblong-oblanceolate from this *S. freitagii* remains distinct by oblong-oblanceolate and 0.5mm long cypsels. Rest of the two species *S. kurramense* and *S. leucotrichum* are grouped due to the presence of oblanceolate and 1 mm long cypsela. The species of second group with well developed carpodium may be further distinguished by having obovoid cypsela in *S. stenocephalum*, ellipsoid cypsela in *S. turanicum* and oblanceolate cypsels are present in *S. sieberi*, *S. quettense* and *S. oliverianum*. These species could be further separated by having yellowish brown cypsela in *S. sieberi* and in remaining two species cypsels are dark brown but these two species could not be separated due to similar cypsela features. For the specific delimitation of the genus *Tanacetum* surface pattern of cypsela was found very useful as all the species are separated into two main groups i.e., cypsels glabrous or with papillate or glandular surface. Group of glabrous cypsels including *T. cinerariifolium*, *T. baltistanicum* and *T. artemisioides*, amongst them *T. cinerariifolium* remains distinct by having broad circular disc like carpodium while in remaining two species carpodium is slightly angular but both the species are separated by having oblanceolate or oblong-oblanceolate cypsels respectively. *T. chitralense* is separated by having 4-ribbed cypsels while in remaining species of this group cypsels are 5-8 ribbed. From these two species viz., *T. falconeri* and *T. parthenium* are separated from the remaining species by having greyish-brown cypsels, furthermore both the species remain distinct due to the difference in pappus structure. In rest of the two species viz. *T. griffithii* and *T. pakistanicum* cypsels are yellowish brown but both the species could be further separated from each other by having 6-8 ribbed and 5-ribbed cypsels, respectively.

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### References

- Abid, R.D. and M. Qaiser. 2002. Cypsela morphology of *Inula* L. (s.str.) and its allied genera (Inuleae-Compositae) from Pakistan and Kashmir. *Pak. J. Bot.*, 34(3): 207-223.
- Abid, R. and M. Qaiser. 2007a. Micromorphology of cypsela in the tribe Plucheeae from Pakistan. *Pak. J. Bot.*, 39(3): 671-677.
- Abid, R. and M. Qaiser. 2007b. Cypsela morphology of the genus *Anaphalis* DC. (Gnaphalieae-Asteraceae) from Pakistan. *Pak. J. Bot.*, 39(6): 1897-1906.
- Abid, R. and M. Qaiser 2008a. Cypsela morphology of *Gnaphalium* L. and its allied genera (Gnaphalieae-Asteraceae) from Pakistan. *Pak. J. Bot.*, 40(1): 25-32.
- Abid, R. and M. Qaiser .2008b. Cypsela morphology of some genera in the tribe Gnaphalieae(Asteraceae) from Pakistan. *Pak. J. Bot.*, 40(2): 473-485.
- Abid, R. and M. Qaiser .2008c. Cypsela morphology and its taxonomic significance of the genus *Artemisia* L. tribe ( Anthemideae-Asteraceae) from Pakistan. *Pak. J. Bot.*, 40(5): 1827-1837.
- Bremer, K. 1994. *Asteraceae Cladistics & Classification*, p.321. Timber Press, Portland, Oregon.
- Dittrich, M. 1968. Morphologische Untersuchungen an den Früchten der subtribus Cardueae-Centaureinae (Compositae). *Willdenowia*, 5: 67-107.
- Ghafoor, A. 2002. *Flora of Pakistan. Asteraceae (I) Anthemideae*. No. 207. (Eds.): S.I. Ali and M. Qaiser. Dept. Bot. Univ. Karachi and Missouri Press. Missouri Botanical Garden, U.S.A.

- Haque, M.Z. and M.B.E. Godward. 1984. New records of the carpopodium in Compositae and its taxonomic use. *Bot. J. Linn. Soc.*, 89: 321-340.
- Kynclova, M. 1970. Comparative morphology of achenes of the tribe *Anthemideae* Cass. (Asteraceae) and its taxonomic significance. *Preslia (Praha)*, 42: 33-53.
- Lovell, P.H., C.D. Maxwell and N. Jacob. 1986. Varieties in cypsela morphology in *Soliva valdiviana* and *S. pterosperma* (Anthemideae, Asteraceae) in a local population at Auckland, Newzealand. *Newzealand J. Bot.*, 24: 657-664.
- Mateu, I. and J. Guemes. 1993. Estudio carpologico del genero *Launaea* Cass. (Asteraceae) en europa. *Bot. Soc. Brot. Ser.*, 2(66): 85-95.
- Merxmuller, H. and J. Grau. 1977. Fruchtanatomische Untersuchungen in der Inula-Gruppe (Asteraceae). *Publ. Cairo Univ.*, 7-8: 9-20.
- Qaiser, M. and R. Abid. 2003. *Flora of Pakistan. Asteraceae (II) Inuleae, Plucheeae & Gnaphalieae*. No. 210. (Eds.): S.I. Ali and M. Qaiser. Dept. Bot. Univ. Karachi and Missouri Press. Missouri Botanical Garden, U.S.A.
- Swelankomo, N., L. Mucina and P.P.J. Herman. 2007. Phenetic classification of cypselas in *Ursinia* (Anthemideae, Asteraceae). *S. Afr. J. Bot.*, 73(2): 316.
- Zhu, SX., HN. Qin and C. Shih. 2006. Achene wall anatomy and surface sculpturing of *Lactuca* L. and related genera (Compositae: Lactuceae) with notes on their systematic significance. *J. Integ. Pl. Bio.*, 48(4): 390-399.

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