

CYPSELA MORPHOLOGY OF THE GENUS *PULICARIA* GAERTN., (INULEAE-ASTERACEAE) FROM PAKISTAN

RUBINA ABID AND M. QAISER

*Department of Botany,
University of Karachi, Karachi-75270, Pakistan.*

Abstract

Cypsela morphology of 11 species of the genus *Pulicaria* Gaertn., belonging to the tribe Inuleae of the family Asteraceae was examined using light and scanning electron microscopy. Cypsela micromorphological characters are found useful to strengthen the specific delimitation of the genus *Pulicaria* from Pakistan.

Introduction

The genus *Pulicaria* Gaertn., belonging to the tribe Inuleae of the family Asteraceae is represented by 14 species in Pakistan (Qaiser & Abid, 2003). In the tribe Inuleae various micromorphological characters have proved significant for taxonomic interpretation such as pollen grains (Skvarla & Turner, 1966; Leins, 1971; Dawar *et al.*, 2002), endothecium (Dormer, 1962; Anderberg, 1991; Abid & Qaiser, 2004a), receptacular surfaces and anther apices (Abid & Qaiser, 2004b), anther collar (Meiri & Dalberger, 1986) and cypsela characters (Abid & Qaiser, 2002). However, micromorphological characters of *Pulicaria* are either totally ignored or only seldom mentioned inspite of stability of characters. In the present studies cypsela morphology of *Pulicaria* species have been carried out from Pakistan.

Materials and Methods

Mature cypselas of 11 species of *Pulicaria* were collected from herbarium specimens (Appendix I) and examined for cypsela morphological characters under stereomicroscope (Nikon XN Model), compound microscope (Nikon Type 102) and scanning electron microscope (JSM-6380A). For scanning electron microscopy dry 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.

Cypsela: Shape, Colour, Size, Surface, Number of ribs.

Pappus: Series, Number, Colour, Length, Degree of division of outer pappus scales.

Carpopodium: Shape and position of carpopodium were studied by SEM. For diameter of carpopodium and its foramen, carpopodium was detached and measurements were recorded in μm under compound microscope.

Appendix I. List of the voucher specimens.

Taxa	Collector and Harbarium number
<i>Pulicaria dysentrica</i>	M.A. Siddiqi & Y. Nasir 6443 (RAW); M.A. Siddiqi & Y. Nasir 4314 (RAW).
<i>P. vulgaris</i>	R.R. Stewart 10607 (RAW); R.R. Stewart & Kohli 52(RAW).
<i>P. arabica</i>	Hassanuddin 76(RAW); W.A. Dick-Peddie 41(RAW); A.H. Khan s.n. (RAW).
<i>P. baluchistanica</i>	M. Qaiser 36(KUH).
<i>P. angustifolia</i>	Razia Ahmed 28(KUH); A.A. Qureshi s.n. (KUH); Zeenat A. Razzak & Momin A. Razzak 76 (KUH); Qamar Sultana s.n. (KUH); S.M.H. Jafri & Akbar 1130 (KUH); S.M. H. Jafri s.n. (KUH).
<i>P. salviifolia</i>	Hassan uddin 103(RAW); Tahir <i>et al.</i> , 2218(KUH); Jan Alam 263(KUH); S. Omer & M. Qaiser 2282 (KUH); R.R. Stewart 26355 (RAW).
<i>P. gnaphalodes</i>	S.A. Farooqi & M. Qaiser 2339 (KUH); S. Khatoon & Mola Baksh 499(KUH); S. Omer 1247 (KUH); M. Qaiser & A. Ghafoor 1181 (KUH); Khairuddin s.n. (RAW).
<i>P. undulata</i>	Tahir Ali 990 (KUH); S. Abedin & Abrar Hussain 7201 (KUH); A. Ghafoor & Steve M. Goodman 4964 (KUH); S. Abedin 7584 (KUH); S. Omer 2909 (KUH); Tahir Ali 679 (KUH); Surayya Khatoon s.n. (KUH); S.I. Ali s.n. (KUH).
<i>P. glaucescens</i>	Tahir Ali & Tufail Ahmed 1771 (KUH); S.A. Farooqi & M. Qaiser 2285 (KUH); A. Ghafoor & S. Omer 1800 A (KUH).
<i>P. carnosia</i>	S.M.H. Jafri 2927 (KUH); S. Omer & A. Ghafoor 1150 (KUH); Tahir Ali 113 (KUH); S.I. Ali & S.A. Farooqi s.n.(KUH).
<i>P. boissieri</i>	Tahir Ali & G.R. Sarwar 2626 (KUH); Saood Omer 1152 (KUH); S.I. Ali s.n. (KUH); Kamal A. Malik <i>et al.</i> , 2232 (KUH).

Observations**General cypsela characters of the species examined**

Cypsela oblong, ellipsoid or oblanceolate, angular or non angular, 1-2.5x 0.5-1.0mm, yellowish-brown, 4-10-ribbed or non-ribbed, glabrous or hairy. Pappus biseriate, dimorphic, outer ones scaly, connate forming a crown; inner ones bristly, barbellate, whitish or golden, bristles 8-24 in number, 2-4mm long. Carpodium broad disc like or narrow circular ring or slightly angular, with or without an interruption, basal or sub-basal in position.

Key to the species

- 1 +Cypsela angular 2
 -Cypsela non angular 3
- 2 +Cypsela oblanceolate, sparsely pubescent, ribs distinct. Carpodium broad circular disc and sub-basal in position *P. angustifolia*

- Cypsela oblong and dense silky hairy, ribs indistinct. Carpodium narrow circular ring and basal in position *P. carnosa*
- 3 +Cypsela with distinct ribs 6
- Cypsela faintly ribbed or unribbed 4
- 4 +Cypsela oblanceolate, sparsely pubescent. Carpodium sub-basal in position 5
- Cypsela oblong, dense silky hairy. Carpodium basal in position ... *P. glaucescens*
- 5 +Cypsela 2.5mm long. Bristles 20-28 in number. Carpodium somewhat angular *P. salviifolia*
- Cypsela 1.0mm long. Bristles 6-8 in number. Carpodium circular disc like *P. vulgaris*
- 6 +Cypsela 4-6- ribbed 7
- Cypsela 8-10- ribbed 10
- 7 +Cypsela 4- ribbed, glabrous or with dense silky hairs 8
- Cypsela 4-6 ribbed, sparsely pubescent 9
- 8 +Cypsela ellipsoid, glabrous. Carpodium with an interruption, sub-basal in position *P. undulata*
- Cypsela oblong, dense silky hairy. Carpodium without an interruption, basal in position *P. boissieri*
- 9 +Outer pappus scales divided up to the middle, 0.25mm long. Carpodium 126µm in diameter *P. arabica*
- Outer pappus scales divided above the middle, 0.5mm long. Carpodium 176µm in diameter *P. baluchistanica*
- 10 +Cypsela oblong-oblanceolate, 10-ribbed. Outer pappus scales divided up to the middle. Carpodium 190 µm in diameter *P. dysentrica*
- Cypsela oblanceolate, 8-ribbed. Outer pappus scales divided below the middle. Carpodium 150 µm in diameter *P. gnaphalodes*

Result and Discussion

Among all of the genera of Inuleae the genus *Pulicaria* Gaertn., is characterized by the presence of outer pappus scales in the form of a short coronate cup (Qaiser & Abid, 2003). Similarly, micromorphological characters of cypsela are also found useful to support the recognition of infrageneric taxa of the genus *Pulicaria*. All the taxa can be divided into two main groups: (i) angular cypselas and (ii) non-angular cypselas. Angular cypselas are found in *P. angustifolia* DC., and *P. carnosa* (Boiss.) Burkill, while in the remaining species cypselas are non angular (Table 1). Furthermore, both the species with angular cypselas can be delimited by the presence of oblanceolate, distinctly ribbed and sparsely pubescent cypselas with broad disc like and sub basal carpodium in *P. angustifolia* (Fig. 1 I, J). While in *P. carnosa* cypselas are oblong, indistinctly ribbed, dense silky hairy and carpodium is narrow ring like and basal in position (Fig. 2 G, H).

Table 1. Micromorphological characters of cypselae of *Pulicaria*.

Name of taxa	Cypselae					Pappus			Carpopodium					
	Shape	Surface (hairs)	No. of ribs	Colour	Size (mm)	Outer (Scales)		Inner (Bristles)			Shape	Position	Diameter of carpopodium (μm)	Diameter of foramen of carpopodium (μm)
						Degree of division	Length (mm)	Number	Length (mm)	Colour				
<i>Pulicaria dysenterica</i>	Oblong-oblancoelate, non-angular	Sparsely pubescent	10 (distinct)	Brown	1.0 x 0.5	Up to the middle	0.25	18	4-5	Golden	Broad circular disc without any interruption	Sub-basal	190	75
<i>P. vulgaris</i>	Oblong, non-angular	Sparsely pubescent	0	Brown	1.0 x 0.5	Below the middle	0.5	6-8	3-4	Dirty white	Broad circular disc without any interruption	Sub-basal	154	58
<i>P. arabica</i>	Oblong-oblancoelate, non-angular	Sparsely pubescent	4-6 (distinct)	Brown	1.5 x 0.5	Up to the middle	0.25	10-14	3-4	Dirty white	Broad circular disc without any interruption	Sub-basal	126	73
<i>P. baluchistanica</i>	Oblong, non-angular	Sparsely pubescent	6 (distinct)	Brown	1.5 x 0.25	Above the middle	0.5	8-10	3-4	White	Broad circular disc without any interruption	Sub-basal	176	92
<i>P. angustifolia</i>	Oblancoelate angular	Sparsely pubescent	8 (distinct)	Yellowish brown	1.5 x 0.75	Below the middle	0.75	10-12	3-4	Golden	Broad circular disc without any interruption	Sub-basal	190	103
<i>P. subvifolia</i>	Oblong-oblancoelate, non-angular	Sparsely pubescent	6 (Faint)	Brown	2.5 x 0.75	Below the middle	0.5	20-28	3-4	Dirty white	Slightly angular ring, with an interruption	Sub-basal	170	115
<i>P. graphalodes</i>	Oblancoelate, non-angular	Sparsely pubescent	8 (distinct)	Brown	1.5 x 0.75	Below the middle	0.5	14	3-4	Dirty white	Broad circular disc without any interruption	Sub-basal	150	73
<i>P. undulata</i>	Ellipsoid non-angular	Glabrous	4 (distinct)	Brown	1.0 x 0.75	Below the middle	0.25	10	2-3	White	Circular ring with an interruption	Sub-basal	80	36
<i>P. glaucerens</i>	Oblong non-angular	Dense silky hairs	0	Brown	2.0 x 0.75	Up to the middle	0.25	14	5.0	Golden	Slightly angular without any interruption	Basal	381	254
<i>P. carmosa</i>	Oblong, non-angular	Dense silky hairs	0	Yellowish brown	1.5 x 0.75	Above the middle	0.25	14	4.0	Golden	Circular ring without any interruption	Basal	273	153
<i>P. boissieri</i>	Oblong, non-angular	Dense silky hairs	4 (distinct)	Yellowish brown	2.0 x 1.0	Above the middle	0.5	12	5.0	Golden	Circular ring without any interruption	Basal	375	240

Fig. 1. Scanning electron micrographs. *Pulicaria dysentrica*: A, cypsela; B, carpopodium. *P. vulgaris*: C, cypsela; D, carpopodium. *P. arabica*: E, cypsela; F, carpopodium. *P. baluchistanica*: G, cypsela; H, carpopodium. *P. angustifolia*: I, cypsela; J, carpopodium. *P. salviifolia*: K, cypsela, L, carpopodium (scale bar: A,C,E,G,I,K= 200µm; B,D,F,H,L = 20µm; J = 50µm).

Taxa with non-angular cypselas may be further separated into two groups one group having faintly ribbed or non-ribbed cypselas including *P. glaucescens* (Boiss.) Jaub. & Spach, *P. salviifolia* Bunge and *P. vulgaris* Gaertn., from which *P. glaucescens* is characterized by oblong, non ribbed, dense silky hairy cypselas with basal carpopodium (Fig. 2 E, F) and in *P. salviifolia* and *P. vulgaris* cypselas are oblanceolate, sparsely hairy and carpopodium is subbasal in position but both the species are distinguished by the presence of 20-28 bristles and somewhat angular carpopodium in *P. salviifolia* (Fig. 1K, L) and in *P. vulgaris* bristles are 6-8 in number and carpopodium is circular disc like (Fig. 1 C, D). Another group of non-angular cypselas having 4-10 distinct ribs further

Fig. 2. Scanning electron micrographs. *Pulicaria gnaphalodes*: A, cypsela; B, carpodium. *P. undulata*: C, cypsela; D, carpodium. *P. glaucescens*: E, cypsela; F, carpodium. *P. carnosae*: G, cypsela; H, carpodium. *P. boissieri*: I, cypsela; J, carpodium (Scale bar: A,E,G,I = 500 µm; B = 20 µm; D = 10 µm; F,H = 50 µm; C,J = 100 µm).

divided into two subgroups, one with 4-6-ribbed cypselas including *P. undulata* (L.) C.A. Meyer, *P. boissieri* Hook.f., *P. arabica* (L.) Cass., and *P. baluchistanica* Qaiser & Abid, and the second subgroup with 8-10-ribbed cypselas comprises *P. dysentrica* (L.) Gaertn., and *P. gnaphalodes* (Vent.) Boiss. Taxa having 4-6 ribbed cypselas are further separated by having only 4 ribs i.e., *P. undulata* (Fig. 2C,D) and *P. boissieri* (Fig. 2 I, J) but both the species remain distinct by the presence of glabrous and dense silky hairy cypselas, respectively. The cypselas with 4-6 ribs including *P. arabica* (Fig. 1E, F) and *P. baluchistanica* (Fig. 1G,H), also show close relationship macromorphologically but differ with each other by having completely herbaceous phyllaries in *P. arabica* and in *P. baluchistanica* upper half of phyllaries is herbaceous (Qaiser & Abid, 2003). Similar to

macromorphology, cypselas micromorphological characters also show differences in the degree of division of pappus scales and carpodium size. The remaining two species i.e., *P. dysentrica* and *P. gnaphalodes* are coupled by the presence of 8-10 ribbed cypselas but *P. gnaphalodes* (Fig. 2A, B) is further distinguished by having 8-ribbed cypselas. Whereas, *P. dysentrica* (Fig. 1A,B) is characterized by 10 ribbed cypselas that makes it distinct from rest of the species of the genus *Pulicaria*. Therefore, the micromorphological characters of cypselas have proved very rewarding for the specific delimitation of the genus *Pulicaria*.

Acknowledgement

We are grateful to Mr. Mohammad Farooq of the Karachi University Herbarium for scanning electron microscopy.

References

- Abid, R. and M. Qaiser. 2004a. The Endothecium in *Inula* L. and its allied genera (Inuleae-Compositae) from Pakistan and Kashmir. *Pak. J. Bot.*, 36(3): 481-486.
- Abid, R. and M. Qaiser. 2004b. A micromorphological study for the generic delimitation of *Inula* L. (s.str.) and its allied genera (Inuleae-Compositae) from Pakistan and Kashmir. *Pak. J. Bot.*, 36(4): 719-724.
- Abid, R.D. and M. Qaiser. 2002. Cypselas morphology of *Inula* L. (s.str.) and its allied genera (Inuleae-Compositae) from Pakistan and Kashmir. *Pak. J. Bot.*, 34(3): 207-223.
- Anderberg, A.A. 1991. Taxonomy and phylogeny of the tribe Inuleae (Asteraceae). *Pl. Syst. Evol.*, 176: 75-123.
- Dawar, R., M. Qaiser and A. Perveen. 2002. Pollen morphology of *Inula* L. (s.str.) and its allied genera (Inuleae-Compositae) from Pakistan and Kashmir. *Pak. J. Bot.*, 34(1): 9-22.
- Dormer, K.J. 1962. The fibrous layer in the anther of Compositae. *New Phytologist*, 61: 150-153.
- Leins, P. 1971. Pollen systematische studien an Inulean. I. Tarcho-nanthinae, Plucheinae, Inulinae, Buphthalminae. *Jharbucher fur systematik, pflanzengeschichte und pflanzengeographie Botanisches*, 91: 91-146.
- Meiri, L. and R. Dulberger. 1986. Stamen filament structure in the Asteraceae: The anther collar. *The New Phytologist*, 104(4): 693-701.
- 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.
- Skvarla, J.J. and B.L. Turner. 1966. Systematic implication from electron microscopic studies of Compositae pollen. *A. Review Annals Missouri Botanical Garden*, 53: 200-256.

(Received for publication 12 December 2006)