

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

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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*

- Cypselas oblong and dense silky hairy, ribs indistinct. Carpopodium narrow circular ring and basal in position *P. carnosa*
- 3 +Cypselas with distinct ribs 6
- Cypselas faintly ribbed or unribbed 4
- 4 +Cypselas oblanceolate, sparsely pubescent. Carpopodium sub-basal in position 5
- Cypselas oblong, dense silky hairy. Carpopodium basal in position ... *P. glaucescens*
- 5 +Cypselas 2.5mm long. Bristles 20-28 in number. Carpopodium somewhat angular *P. salviifolia*
- Cypselas 1.0mm long. Bristles 6-8 in number. Carpopodium circular disc like *P. vulgaris*
- 6 +Cypselas 4-6- ribbed 7
- Cypselas 8-10- ribbed 10
- 7 +Cypselas 4- ribbed, glabrous or with dense silky hairs 8
- Cypselas 4-6 ribbed, sparsely pubescent 9
- 8 +Cypselas ellipsoid, glabrous. Carpopodium with an interruption, sub-basal in position *P. undulata*
- Cypselas oblong, dense silky hairy. Carpopodium without an interruption, basal in position *P. boissieri*
- 9 +Outer pappus scales divided up to the middle, 0.25mm long. Carpopodium 126µm in diameter *P. arabica*
- Outer pappus scales divided above the middle, 0.5mm long. Carpopodium 176µm in diameter *P. baluchistanica*
- 10 +Cypselas oblong-oblanceolate, 10-ribbed. Outer pappus scales divided up to the middle. Carpopodium 190 µm in diameter *P. dysentrica*
- Cypselas oblanceolate, 8-ribbed. Outer pappus scales divided below the middle. Carpopodium 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 cypselas 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 carpopodium in *P. angustifolia* (Fig. 1 I, J). While in *P. carnosa* cypselas are oblong, indistinctly ribbed, dense silky hairy and carpopodium is narrow ring like and basal in position (Fig. 2 G, H).

Fig. 1. Scanning electron micrographs. *Pulicaria dysentrica*: A, cypsel; B, carpodium. *P. vulgaris*: C, cypsel; D, carpodium. *P. arabica*: E, cypsel; F, carpodium. *P. baluchistanica*: G, cypsel; H, carpodium. *P. angustifolia*: I, cypsel; J, carpodium. *P. salviifolia*: K, cypsel, L, carpodium (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 carpodium (Fig. 2 E, F) and in *P. salviifolia* and *P. vulgaris* cypselas are oblanceolate, sparsely hairy and carpodium is subbasal in position but both the species are distinguished by the presence of 20-28 bristles and somewhat angular carpodium in *P. salviifolia* (Fig. 1K, L) and in *P. vulgaris* bristles are 6-8 in number and carpodium 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, carpopodium. *P. undulata*: C, cypsela; D, carpopodium. *P. glaucescens*: E, cypsela; F, carpopodium. *P. carnos*a: G, cypsela; H, carpopodium. *P. boissieri*: I, cypsela; J, carpopodium (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 carpopodium 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*.

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