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CYPSELA MORPHOLOGY OF THE GENUS *ANAPHALIS* DC. (GNAPHALIEAE-ASTERACEAE) FROM PAKISTAN

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Abstract

Cypsela morphology of 17 taxa of the genus *Anaphalis* DC., was examined using light and scanning electron microscopy. On the basis of cypsela surface all the taxa are divided into two main groups and most of the species are delimited due to their distinct micromorphological characters of cypsela.

Introduction

The genus *Anaphalis* DC., belongs to the tribe Gnaphalieae of the family Asteraceae and comprises 15 species in Pakistan (Qaiser & Abid, 2003). The cypsela micromorphological characters have played an important role of systematic significance in the family Astraceae (Kynclova, 1970; Merxmuller & Grau, 1977; Haque & Godward, 1984; Mateu & Guemes, 1993; Abid & Qaiser, 2002; Ritter & Miotlo, 2006; Abid & Qaiser, 2007a, 2007b; Abid & Zehra, 2007). Although in earlier reports on cypsela morphology of the family Astraceae from Pakistan only the tribes Inuleae and Plucheeae (Abid & Qaiser, 2002, 2007a,b; Abid & Zehra, 2007) have been studied.Cypsela characters in the genus *Anaphalis* have not received due attention (Anderberg, 1991; Qaiser & Abid, 2003). The present studies of cypsela morphology are carried out to strengthen the recognition of taxa in the genus *Anaphalis* from Pakistan.

Materials and Methods

Seventeen taxa of the genus *Anaphalis* DC., were studied for cypsela characters 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 under light microscope.

Cypsela: Shape, colour, size, surface.
Pappus: Bristles shape, series, number, size, colour.
Corpopodium: Shape, position, diameter of carpopodium and diameter of foramen of carpopodium were observed under scanning electron microscope.

Observations

General cypsela characters of *Anaphalis*: Cypselas oblong, or ellipsoid or oblong-ellipsoid, slightly angular or non angular, 0.5-1.5 x 0.25-1.0mm, colour varies from

yellowish brown to reddish brown or dark brown, non-ribbed, sparsely or densely papillate-clavate hairy. Pappus uniseriate, bristly, white or off white or golden, 8-18, 1.5-5.0mm long. Carpopodium broad disc like or narrow circular ring or slightly angular, without any interruption, subbasal or basal in position, 85-152µm in diameter. Forammen of carpopodium 58.5-100µm in diameter (Table 1; Figs. 1-3).

Key to the species

1 +Cypselas sparsely papillate-clavate hairy ….…… 2
-Cypselas densely papillate-clavate hairy …….. 4

2 +Cypselas reddish brown. Pappus bristles 16-20. Carpopodium broad circular disc like ……. 3
-Cypselas dark brown. Pappus bristles 10-12. Carpopodium narrow circular ring like …….. *A. adnata, A. busua*

3 +Cypselas oblong-ellipsoid. Carpopodium basal in position, 150µm in diameter, foramen of carpopodium 90µm in diameter …… *A. chitralensis*
-Cypselas ellipsoid. Carpopodium subbasal in position, 130µm in diameter, foramen of carpopodium 68µm in diameter …….. *A. virgata*

4 +Cypselas and carpopodium slightly angular ……. 5
-Cypselas and carpopodium non angular ……... 6

5 +Pappus bristles golden. Carpopodium 148µm in diameter ……... *A. boissieri*
-Pappus bristles white. Carpopodium 106-111µm in diameter …….
……..... *A. royleana* var. *royleana*, var. *cana*, var. *concolor*

6 +Carpopodium broad circular disc like, 88µm in diameter ……... *A. patentifolia*
-Carpopodium narrow circular ring like 100 - 152µm in diameter …… 7

7 +Pappus bristles 16-18. Carpopodium 152µm in diameter, foramen of carpopodium 100µm in diameter …….. *A. scapulosa*
-Pappus bristles 8-12. Carpopodium 100-130µm in diameter, foramen of carpopodium 75-90µm in diameter ……... 8

8 +Cypselas yellowish brown …… *A. stantonii*
-Cypselas dark brown or reddish brown …… 9

9 +Pappus bristles off white ……... *A. contorta*
-Pappus bristles white ……... 10

10 +Cypselas dark brown …… *A. margaritacea, A. triplinervis*
-Cypselas reddish brown …….. 11

11 +Cypselas 0.5 x 0.25mm …….. *A. kashmiriana*
-Cypselas 1.0 x 0.5mm …… *A. nepalensis* var. *nepalensis*, var. *monocephala*

Table 1. Cypsela morphological features of the genus *Anaphalis*.

Name of species	Cypsela			
	Shape	Surface (hairs)	Colour	Size (mm)
Anaphalis adnata	Ellipsoid, non-angular	Sparsely papillose- Clavate	Dark brown	0.5 x 0.25
A. boissieri	Oblong, slightly angular	Densely papillose- Clavate	Yellowish brown	1-1.5 x 0.5
A. busua	Ellipsoid, non-angular	Sparsely papillose- Clavate	Dark brown	0.5 x 0.25
A. chitralensis	Oblong-ellipsoid, non-angular	Sparsely papillose- Clavate	Reddish brown	1.5 x 0.5
A. contorta	Oblong, non-angular	Densely papillose- Clavate	Reddish brown	1.0 x 0.5
A. kashmiriana	Oblong, non-angular	Densely papillose- Clavate	Reddish brown	0.5 x 0.25
A. margaritacea	Oblong, non-angular	Densely papillose- Clavate	Dark brown	1.0 x 0.5
A. nepalensis var. nepalensis	Oblong, non-angular	Densely papillose- Clavate	Reddish brown	1.0 x 0.5
A. nepalensis var. *monocephala*	Oblong, non-angular	Densely papillose- Clavate	Reddish brown	1.0 x 0.5
A. patentifolia	Oblong, non-angular	Densely papillose- Clavate	Yellowish brown	0.75–1.0 x 0.5
A. royleana var. *royleana*	Oblong, slightly angular	Densely papillose- Clavate	Yellowish brown	1.0 x 0.5
A. royleana var. *cana*	Oblong, slightly-angular	Densely papillose- Clavate	Yellowish brown	1.0 x 0.5
A. royleana var. *concolor*	Oblong, slightly angular	Densely papillose- Clavate	Yellowish brown	1.0 x 0.5
A. scapulosa	Oblong, non angular	Densely papillose- Clavate	Dark brown	1.0 x 0.25
A. staintonii	Oblong, non –angular	Densely papillose- Clavate	Yellowish brown	1.0 x 0.5
A. triplinervis	Oblong, non-angular	Densely papillose- Clavate	Dark brown	1.0 x 0.5
A. virgata	Ellipsoid, non-angular	Sparsely papillose- Clavate	Reddish brown	1.5 x 0.5

Table 1. (Cont'd.).

Name of species	Pappus			
	Bristles	Number	Size (mm)	Colour
Anaphalis adnata	Barbellate, basally with patent cilia	10-12	1.5	White
A. boissieri	Barbellate, basally with patent cilia	14-16	3-4	Golden
A. busua	Barbellate, basally with patent cilia	10-12	2.5-3.0	White
A. chitralensis	Barbellate, basally with patent cilia	18-20	3.5-4.0	Off white
A. contorta	Barbellate, basally with patent cilia	10-12	3-4.0	Off white
A. kashmiriana	Barbellate, basally with patent cilia	8-10	3-4.0	White
A. margaritacea	Barbellate, basally with patent cilia	8-10	3.5-5.0	White
A. nepalensis var. *nepalensis*	Barbellate, basally with patent cilia	10-12	3-4	White
A. nepalensis var. *monocephala*	Barbellate, basally with patent cilia	10-12	3-4	White
A. patentifolia	Barbellate, basally with patent cilia	10-12	3-4	White
A. royleana var. *royleana*	Barbellate, basally with patent cilia	14-16	3-4	White
A. royleana var. *cana*	Barbellate, basally with patent cilia	10-12	3.0	White
A. royleana var. *concolor*	Barbellate, basally with patent cilia	10-12	3.0	White
A. scapulosa	Barbellate, basally with patent cilia	16-18	3.0	White
A. staintonii	Barbellate, basally with patent cilia	10-12	3-3.5	White
A. triplinervis	Barbellate, basally with patent cilia	10-12	3-3.5	White
A. virgata	Barbellate, basally with patent cilia	16-18	3-4	Off white

Table 1. (Cont'd.).

Name of species	Carpopodium			
	Shape	Position	Diameter of carpopodium (μm)	Diameter of foramen of carpopodium (μm)
Anaphalis adnata	Narrow circular ring without any interruption	Sub basal	97	63
A. boissieri	Slightly angular without any interruption	Sub basal	148	82
A. busua	Narrow circular ring without any interruption	Sub basal	85	58.5
A. chitralensis	Broad circular disc without any interruption	Basal	150	90
A. contorta	Narrow circular ring without any interruption	Sub basal	110	80
A. kashmiriana	Narrow circular ring without any interruption	Sub basal	100	80
A. margaritacea	Narrow circular ring without any interruption	Sub basal	130	78
A. nepalensis var. *nepalensis*	Narrow circular ring without any interruption	Sub basal	112	75
A. nepalensis var. *monocephala*	Narrow circular ring without any interruption	Sub basal	110	76
A. patentifolia	Broad circular disc without any interruption	Sub basal	88	60
A. royleana var. *royleana*	Slightly angular without any interruption	Sub basal	106	64
A. royleana var. *cana*	Slightly angular without any interruption	Sub basal	111	62
A. royleana var. *concolor*	Slightly angular without any interruption	Sub basal	110	63
A. scapulosa	Narrow circular ring without any interruption	Sub basal	152	100
A. staintonii	Narrow circular ring without any interruption	Sub basal	100	78
A. triplinervis	Narrow circular ring without any interruption	Sub basal	130	90
A. virgata	Broad circular disc without any interruption	Sub basal	130	68

Fig. 1. Scanning Electron micrographs. *Anaphalis adnata*: A, cypsela; B, surface; C, carpopodium. *A. boissieri*: D, cypsela; E, surface; F, carpopodium. *A. busua*: G, cypsela; H, surface; I, carpopodium. *A. chitralensis*: J, cypsela; K, surface; L, carpopodium. *A. contorta*: M, cypsela; N, surface; O, carpopodium (Scale bar: A, D, G= 100µm ; J = 200µm; M = 50µm; B,C,F, K, L, O = 20µm; E = 30µm; H, I, N = 10µm).

Fig. 2. Scanning Electron micrographs. *Anaphalis kashmiriana*: A, cypsela; B, surface; C, carpopodium. *A. margaritacea*: D, cypsela; E, surface; F, carpopodium. *A. nepalensis* var. *nepalensis*: G, cypsela; H, surface; I, carpopodium. *A. patentifolia*: J, cypsela; K, surface; L, carpopodium. *A. royleana* var. *royleana*: M, cypsela; N, surface; O, carpopodium (Scale bar: A, D, G, M = 100µm; J = 50µm; B, E, K, L, N = 10µm; C, F, H, I, O = 20µm).

Fig. 3. Scanning Electron micrographs. *Anaphalis royleana* var. *concolor*: A, cypsela; B, surface; C, carpopodium. *A. scapulosa*: D, cypsela; E, surface; F, carpopodium. *A. staintonii*: G, cypsela; H, surface; I, carpopodium. *A. triplinervis*: J, cypsela; K, surface; L, carpopodium. *A. virgata*: M, cypsela; N, surface; O, carpopodium (Scale bar: A,G= 100µm; D,M = 200µm; J, N = 50µm; B, C, E, F, H, K, L, O = 20µm; I = 10µm).

Results and Discussion

The genus *Anaphalis* DC., is distinguished amongst all of the genera of Gnaphalieae due to the presence of short clavate hairs on cypsela surface (Anderberg, 1991, Bremer, 1994; Qaiser & Abid, 2003). Presently it is observed that cypsela surface is papillate-clavate hairy rather than the clavate hairy only and secondly their density was not considered previously. On the basis of density of these hairs all the taxa of *Anaphalis* are divided into two groups i.e. cypselas sparsely or densely papillate-clavate hairy. Sparsely papillate-clavate cypselas are found in *A. adanata* Wall. ex DC., *A. busua* (Buch.-Ham. ex D.Don) DC., *A. chitralensis* Qaiser & R. Abid and *A. virgata* Thomson ex C.B.Clarke (Figs. 1B, H, K; 3N). Species like *A. adanata* and *A. busua* can be delimited by the presence of dark brown cypselas having 10-12 pappus bristles and narrow circular ring like carpopodium (Fig. 1A, C, G, I).Furthermore both the species can not be separated due to similar cypsela characters while, in *A. chitralensis* and *A. virgata* cypselas are reddish brown with16-20 pappus bristles and broad circular disc like carpopodium (Figs. 1J,L;3M, O) and both the species remain distinct from each other due to differences in cypsela shape, position and diameter of carpopodium. Taxa having densely papillate-clavate cypselas may be further divided into two groups one group with slightly angular cypselas and carpopodium, including *A.boissieri* E. Georgiadou (Fig. 1D, F) and *A. royleana* DC. var. *royleana*, var. *cana* Hook. f. and var. *cancolor* Hook.f. (Figs. 2M, O; 3A, C). *A. boissieri* is further separated from *A. royleana* by the presence of golden pappus bristles and larger carpopodium, while in *A. royleana* pappus bristles are white. Another group of densely papillate-clavate cypselas having non-angular cypselas and carpopodium, from which *A. patentifolia* Rech.f. is distinguished by the presence of broad circular disc like carpopodium (Fig. 2J, L). While in other species carpopodium is narrow circular ring-like, amongst them *A. scapulosa* Boriss., remains distinct from rest of the species due to 16-18 pappus bristles and comparatively larger carpopodium. Another species, *A. staintonii* E. Georgiadou (Fig. 3G, I) is dintinct by having yellowish brown cypselas. While in *A. contorta* (D.Don) Hook.f., *A. kashmiriana* P.C. Pant and *A. nepalensis* (Spreng.) Hand.-Mazz. cypselas are reddish brown but *A. contorta* still remains distinct from both the species due to off white pappus bristles. *A. kashmiriana* and *A. nepalensis* have white pappus bristles. On the other hand the two remaining species *A. margaritacea* (L.) Benth. and *A. triplinervis* (Sims.) C.B. Clarke have dark brown cypselas and both the species could not be separated due to indistinct cypsela features. Therefore for most of the species of *Anaphalis* the micromorphological characters of cypsela are quite stable and characteristic and have systematic importance.

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