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# CYPSELA MORPHOLOGY OF SOME GENERA IN THE TRIBE GNAPHALIEAE (ASTERACEAE) FROM PAKISTAN

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**Abstract**

Micromorphological characters of cypsela of the tribe Gnaphalieae were studied using light and scanning electron microscopy. In all 19 taxa including in *Cymbolaena* smoljan, *Filago* L., *Ifloga* Cass., *Lasiopogon* Cass., *Leontopodium* R.Br. ex Cass., and *Phagnalon* Cass., were examined. Cypsela features were found useful for assessing the taxonomic delimitation both at the generic and specific levels.

## Introduction

Tribe Gnaphalieae of the family Asteraceae is represented in Pakistan by 12 genera and 45 species (Qaiser & Abid, 2003) of which genera *Anaphalis* DC., *Gamochaeta* Wedd., *Gnaphalium* L., *Homognaphalium* Kirp., and *Pseudognaphalium* Kirp., have been previously studied for their cypsela features (Abid & Qaiser, 2007b, 2008). Presently the cypsela morphology of the genera *Cymbolaena* smoljan, *Filago* L., *Ifloga* Cass., *Lasiopogon* Cass., *Leontopodium* R.Br. ex Cass., and *Phagnalon* Cass., is studied for evaluating the taxonomic decisions.

## Materials and Methods

Ninteen taxa of the tribe Gnaphalieae assembled in 6 genera viz., *Cymbolaena*, *Filago*, *Ifloga*, *Lasiopogon*, *Leontopodium* and *Phagnalon* were studied for cypsela 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: Cypsela: Shape, surface, colour, size. Pappus: Bristle's series, shape, number, degree of fusion, colour, size. Carpopodium: Shape, position, diameter of carpopodium and diameter of foramen of carpopodium were observed under scanning electron microscope.

## Observations

### General cypsela characters of Gnaphalieae

Cypsela oblong, oblong-oblanceolate, oblong-obovate, oblanceolate or ellipsoid, 0.75-1.5x0.25-0.5mm, yellowish brown, reddish bown or dark brown, non ribbed, glabrous, long hairy, globose myxogenic twin hairy,papillate or papillate-clavate. Cypsela monomorphic or dimorphic with epappose female and pappose bisexual

cypselas. Pappus uniseriate, bristles scabrid-barbellate, barbellate, plumose or only apically plumose, 3-24, 1.5-8.0mm long, white or yellow, deciduous. Carpopodium narrow or broad circular without any interruption, subbasal in position, 42-170 µm in diameter. Foramen of carpopodium 30-96 µm in diameter (Table 1).

**Appendix 1. List of voucher specimens.**

| Taxa | Collector, number, herbarium |
|---|---|
| *Cymbolaena griffithii* | *M. Qaiser* & *S. Abedin* 5930 (KUH); *S. Omer* 1265 (KUH); *S.M.H. Jafri* s.n. (KUH); *S.Omer* 1192 (KUH); *A. Ghafoor* & *Steve M. Goodman* 5063 (KUH). |
| *Filago arvensis* | *A. Ghafoor* & *S. Omer* 3266(KUH); *S. Omer* & *M. Qaiser* 2317 (KUH); *S.M.H. Jafri* & *Akbar* 2121(KUH); *R.R. Stewart* & A. Rahman 25151 (RAW). |
| *F. desertorum* | *M. Qaiser, Asad Raza & A. Hussain* 1000 (KUH); *A. Ghafoor & Steve. M. Goodman* 4745 (KUH). |
| *F. hurdwarica* | *Tahir Ali* & *G.R. Sarwar* 2798 (KUH); *Kamal A. Malik, S. Omer* & *A. Wahid* 2314 (KUH); *Y. Nasir* & *M.A. Siddiqui* 8241(RAW). |
| *F. paradoxa* | *A. Ghafoor* & *S. Omer* 3023 (KUH); *S. Omer* & *M. Qaiser* 2703 (KUH); *A. Ghafoor* & *Steve M. Goodman* 4587 (KUH); *R.R. Stewart* 27293 (RAW). |
| *F. pyramidata* | *R.R. Stewart* 13805 (KUH); *A. Ghafoor* & *S. Omer* 2150 (KUH). |
| *Ifloga spicata* | *M. Qaiser* & *A. Ghafoor* 7438 (KUH); *R.R. Stewart* 15311 (KUH); *A. Ghafoor* & *M. Qaiser* 62 (KUH); *S. Abedin* & *Abrar Hussain* 7252 (KUH); *A. Ghafoor* & *Steve M. Goodman* 4458 (KUH); *Malhotra* s.n. (RAW). |
| *Lasiopogon muscoides* | *S. Omer, M. Qaiser & Y. Nasir* 2159 (KUH); *A. Ghafoor* & *Steve M. Goodman* 5057 (KUH); *Kamal A. Malik etal*. 2380 (KUH). |
| *Leontopodium brachyactis* | *S.M.A. Kazmi* s.n. (KUH); *M. Qaiser* & *A. Ghafoor* 1833 (KUH); *S. Abedin* & *M. Qaiser* 9033 (KUH); *S.M.H. Jafri* & *Ali* 3173 (KUH). |
| *L. himalayanum* | *R.R. Stewart* 6634 (RAW). |
| *L. jacotianum* | *R.R. Stewart* s.n. (KUH); *S. Omer* & *M. Qaiser* 2640 (KUH); *F. Schmid* 326 (RAW). |
| *L. leontopodinum* | *Jan Alam* & *Aziz* 1068 (KUH); *Jan Alam* & *Fazal Karim* 1303 (KUH); *S.I. Ali*, *W. Sugong* & *Tahir Ali* 3389 (KUH); *R.R. Stewart* 12642 (RAW). |
| *L. nanum* | *Walter Koelz* 2179 (RAW); *Jan Alam* & A. *Aziz* s.n. (KUH). |
| *Phagnalon acuminatum* | *Ulfat Hussain zargar* 495 (KUH); *S. Omer* & *A. Ghafoor* 1824 (KUH); *M. A. Siddiqui* 27100 (RAW); *Dick-Peddie* 26 (RAW). |
| *P. daravazicum* | *S. Omer* & *A. Ghafoor* 1797 (KUH). |
| *P. niveum* | *Ali* 1109 (KUH); *M. Qaiser* & *S. Abedin* 5624 (KUH); *Sadruddin* s.n. (KUH); *Tahir Ali* & *G.R. Sarwar* 2738 (KUH); *A. Ghafoor* & *Tahir Ali* 3700 (KUH). |
| *P. pycnophyllon* | *S. Nazimuddin* & *S. Abedin* 1071 (KUH); *S.M.A. Kazmi* 1698 (RAW); *R.R. Stewart* 570 (RAW). |
| *P. schweinfurthii var. androssovii* | *S. Omer* & *A. Ghafoor* 1381 (KUH); *S.M.H. Jafri* & *Akbar* 2331B (KUH); *S.M.H. Jafri* 2925 (KUH). |
| *P. schweinfurthii var. lamondae* | *S.M.A. Kazmi* 1149 (RAW). |

**Key to the genera**

1 + Cypselas epappose in only female florets and pappose in bisexual ones …… 2
- Cypselas pappose in both female and bisexual florets ……..…… 4

2 + Cypselas oblong-oblanceolate, oblong-obovate, obovate, pappillate, clavate or with globose myxogenic twin hairs. Pappus bristles 8-16 and 2-3.5mm long …… 3
- Cypselas oblanceolate, glabrous. Pappus bristles 3-4 and 1.5mm long ……..…… ……. *Cymbolaena*

3 + All cypselas of female florets epappose. Pappus bristles plumose apically and barbellate at base, free ……... *Ifloga*
- Cypselas of outer female florets epappose and pappose of inner ones. Pappus bristles barbellate throughout ……... *Filoga*

4 + Cypselas with globose myxogenic twin hairs. Pappus bristles plumose. Carpopodium narrow circular ring like ……..…….. *Lasiopogon*
- Cypselas glabrous, papillate, papillate-clavate or long hairy. Pappus bristles scabrid -barbellate or barbellate. Carpopodium broad circular disc like …….. 5

5 + Cypselas long hairy. Pappus bristles yellow and free …….. *Phagnalon*
- Cypselas glabrous, papillate or papillate-clavate. Pappus bristles white and basally fused …… *Leontopodium*

***Cymbolaena*** Smoljan

It is represented by single species viz., *C. griffithii* (A.Gray) Wagenitz

Cypselas dimorphic, bisexual (functionally male) pappose, female ones epappose, oblanceolate, 1.5x0.5, yellowish brown, glabrous. Pappus uniseriate, barbellate, free, deciduous white, 3-4, 1.5mm long. Carpopodium broad circular disc like without any interruption subbasal in position, 90µm in diameter. Foramen of carpopodium 50µm in diameter (Table 1; Fig. 1A-D).

***Filago*** L.

It is represented by 5 species viz., *F.arvensis* L., *F. desertorum* Pomel, *F. hurdwarica* (Wall.ex DC.) Wagenitz, *F. paradoxa* Wagenitz, *F. pyramidata* L.

Cypselas dimorphic, outer female eppapose, inner female and bisexual ones pappose, obovate or oblong-oblanceolate, 0.75-1.5x0.25-0.5mm,yellowish brown, sparsely papillate, papillate-clavate or globose-clavate hairy. Pappus uniseriate, barbellate, basally fused, deciduous, white, 8-16, 2.5 -3.5mm long. Carpopodium narrow circular ring without any interruption, subbasal in position, 72-88µm in diameter. Foramen of carpopodium 53-66µm in diameter (Table 1; Fig. 2A-O).

Fig. 1. Scanning Electron Micrographs. *Cymbolaena griffithii*: A, female cypsela; B, surface; C, carpopodium; D, bisexual cypsela. *Ifloga spicata:* E, cypsela; F, surface: G, carpopodium. *Lasiopogon muscoides:* H, cypsela; I, surface: J, carpopodium (scale bar: A, D, E, H= 100 µm; B, F, I= 20µm; C, G =10µm; J= 15µm).

**Key to the species of *Filago***

1 + Cypselas globose-clavate hairy, 0.75mm long ……. 2
- Cypselas papillate or papillate-clavate hairy, 1-1.5mm long ……... 3

2 + Pappus bristles 8-10. Carpopodium 72 µm in diameter …….. *F. pyramidata*
- Pappus bristles 10-12. Carpopodium 80 µm in diameter ……..…….. *F. paradoxa*

3 + Cypselas papillate–clavate …… 4
- Cypselas papillate ……. *F. arvensis*

4 + Cypselas obovate. Carpopodium 80µm in diameter …….. *F. hurdwarica*
- -Cypselas oblong-oblanceolate. Carpopodium 88µm in diameter ….. *F. desertorum*

Fig. 2. Scanning Electron Micrographs. *Filoga arvensis*: A, cypsela; B, surface; C, carpopodium. *F. desertorum*: D, cypsela; E, surface; F, carpopodium. *F.hurdwarica*: G, cypsela; H, surface; I, carpopodium. *F. paradoxa*: J, cypsela; K, surface; L, carpopodium. *F. pyramidata*; M, cypsela; N, surface; O, carpopodium (Scale bar: A, D, G, J, M= 100µm; B, E, K, N= 20µm; H= 50µm; C, F, I, L, O= 10µm).

***Ifloga*** Cass.

It is represented by single species viz., *I. spicata* (Forssk.) Sch.-Bip.
Cypselas dimorphic, bisexual pappose, female epappose, oblong-obovoid, 0.5-0.75x0.25mm, reddish brown with globose myxogenic twin hairs. Pappus uniseriate, barbellate but apically plumose, deciduous, white, 6-10, 2mm long. Carpopodium broad circular disc like without any interruption, subbasal in position, 68µm in diameter. Foramen of carpopodium 55 µm in diameter (Table 1; Fig. 1E-G).

***Lasiopogon*** Cass.

It is represented by single species viz., *L. muscoides* (Desf.) DC.
Cypselas monomorphic, ellipsoid, 0.5x0.25mm, yellowish brown, globose myxogenic twin hairy. Pappus uniseriate, plumose, free, deciduous, white, 8-10, 2mm long. Carpopodium narrow circular ring like without any interruption, subbasal in position, 42µm in diameter. Foramen of carpopodium 30 µm (Table 1; Fig. 1H-J).

***Leontopodium*** R. Br. ex Cass.

It is represented by five species viz., *L. brachyactis* Gandoger, *L. himalayanum* DC. *L. jacotianum* Beauv., *L. Leontopodinum* (DC.) Hand.-Mazz., *L. nanum* (Hook f. & Thomson ex C.B. Clarke) Hand.-Mazz.

Cypselas monomorphic, oblong or ellipsoid, 1-1.5x0.25-0.5 mm, dark brown, glabrous, sparsely papillate or papillate-clavate. Pappus uniseriate, barbellate, basally fused, deciduous, white, 12-32, 3-8mm long. Carpopodium broad circular disc like without any interruption, subbasal in position, 105-170µm in diameter. Foramen of carpopodium 48-96µm in diameter (Table 1; Fig. 3A-O).

**Key to the species of *Leontopodium***

1 + Cypselas glabrous. Carpopodium 105 µm in diameter …… *L. Leontopodinum*
- Cypselas papillate or papillate-clavate. Carpopodium 117-170µm in diameter ….. 2

2 + Cypsela sparsely papillate. Carpopodium 117-135µm in diameter …….. 3
- Cypsela sparsely papillate-clavate. Carpopodium 160-170µm in diameter …… 4

3 + Pappus bristles 12-14, upto 5mm long. Carpopodium 17 µm in diameter …….. …….. *L. brachyactis*
- Pappus bristles 24-32, 7-8mm long. Carpopodium 135 µm in diameter … *L. nanum*

4 + Cypselas oblong. Carpopodium 160µm in diameter. Foramen of carpopodium 96µm in diameter ……. *L. jacotianum*
- Cypselas oblong or ellipsoid. Carpopodium 170 µm in diameter. Foramen of carpopodium 60µm in diameter ……..…. *L. himalayanum*

Fig. 3. Scanning Electron Micrographs. *Leontopodium brachyactis*: A, cypsela; B, surface; C, carpopodium. *L. himalayanum*: D, cypsela; E, surface; F, carpopodium. *L. jacotianum*: G, cypsela; H, surface; I, carpopodium. *L. leontopodinum*: J, cypsela; K, surface; L, carpopodium. *L. nanum:* M, cypsela; N, surface; O, carpopodium. (Scale bar: A, G, M= 200 µm; D, J= 100µm; C, E, F, H, I, K, N, O= 20µm; B= 50µm; L= 10µm).

Fig. 4. Scanning Electron Micrographs. *Phagnalon acuminatum*: A, cypsela; B, carpopodium.*P. daravazicum*; C, cypsela: D, carpopodium. *P. niveum:* E, cypsela; F, carpopodium. *P. pycnophyllon*: G, cypsela; H, carpopodium. *P. schweinfurthii* var. *androssovii:* I, cypsela: J, carpopodium. (Scale bar: A, C, I= 200µm; E, G= 100µm; B, D, F, H, J= 20µm).

***Phagnalon*** Cass.

It is represented by 5 species viz., *P. acuminatum* Boiss., *P. daravazicum* H. Krasch., *P. niveum* Edgew., *P. pycnophyllon* Rech.f., *P. schweinfurthii* Sch.- Bip. ex *Schweinf.* var. *androssovii* (B. Fedtsch.) Qaiser & Lack, *P. schweinfurthii* Sch.- Bip. ex *Schweinf.* var. *lamondae* Qaiser & Lack.

Cypselas monomorphic, oblong or ellipsoid, 1-1.5x0.25-0.5mm, dark brown, long hairy. Pappus uniseriate, barbellate or scabrid–barbellate, free, deciduous, yellow, 5-9mm long. Carpopodium broad circular disc like without any interruption, 112-164µm in diameter. Foramen of carpopodium 40-65 µm in diameter (Table 1; Fig. 4A-J).

**Key to the species of *Phagnalon***

1 + Carpopodium upto 135µm in diameter. Foramen of carpopodium 40-42 µm in diameter ……..…2
- Carpopodium 145-164µm in diameter. Foramen of carpopodium 55-65 µm in diameter …… 3

2 + Pappus bristles scabrid-barbellate, 6-9. Carpopodium 135µm in diameter ……. ……..… *P. acuminatum*
- Pappus bristles barbellate, 5. Carpopodium 112µm in diameter …… *P. niveum*

3 + Pappus bristles scabrid-barbellate. Carpopodium 164µm in diameter ……. ……...……. *P. daravazicum*
- Pappus bristles barbellate. Carpopodium 145-155µm in diameter …….. 4

4 + Carpopodium 145µm in diameter. Foramen of carpopodium 55µm in diameter …..... ……... *P. pycnophyllon*
- Carpopodium 152-155µm in diameter. Foramen of carpopodium 63-65 µm in diameter ……...…… *P. schweinfurthii*

**Result and Discussion**

In the family Asteraceae cypsela morphology has been proved very useful for the taxonomic delimitation at tribal level such the tribes Helianthae and Eupatorieae are distinguished from rest of the tribes due to carbonized cypselas (Anderberg, 1991; Bremer, 1994). The tribe Inuleae is usually characterized by the presence of calcium oxalate crystals in the cypsela epidermis (Mermuller & Grau, 1977; Anderberg, 1991; Breitwiesser & Ward 2005). However, similar to the tribe Plucheeae (Abid & Qaiser, 2007a) Gnaphalieae do not have characteristic cypsela but cypsela morphology is very helpful for infratribal delimitation. On the basis cypsela morphology all the taxa of Gnaphalieae are divided into two groups such as cypselas monomorphic or dimorphic. Monomorphic cypselas are found in the genera *Lasiopogon, Leontopodium* and *Phagnalon,* where the genus *Lasiopogon* is characterized by having the cypselas with globose myxogenic twin hairs and plumose pappus bristles. While in the genus *Leontopodium* cypselas are either glabrous, papillate or papillate-clavate with barbellate and basally fused pappus bristles. *Phagnalon* is distinct due to long hairs on cypsela with free and scabrid-barbellate or barbellate pappus bristles. Taxa with dimorphic cypselas may be further divided into two subgroups one group with epappose cypselas in all

female florets and bisexual ones pappose including *Cymbolaena* and *Ifloga*. Furthermore both the genera are distinct from each other due to glabrous cypselas with 3-4 barbellate pappus bristles in *Cymbolaena* whereas, *Ifloga* cypsela has globose myxogenic hairs with 8-10 barbellate but apically plumose bristles. However, importance of cypsela morphology is also evident at specific level such as species of *Filago* are distinguished on the basis of cypsela surface, as the globose-clavate hairs are found in *F. paradoxa* and *F. pyramidata*. While, *F. desertorum* and *F. hurdwarica* are distinct from the other species due to sparsely papillate-clavate cypselas and the species of both groups differ from each other due to the size of carpopodium. However, papillate surface is characteristic for *F. arvensis*. All the species of *Leontopodium* are also distinguished from each other as *L. leontopodinum* is characterized by glabrous cypsela and in remaining species cypselas are papillate or papillate-clavate. *L. nanum* is the only species in which pappus bristles are 32 and 7-8mm long, while in rest of the species pappus bristles are 12-24 and 3-5mm long. Furthermore, *L. brachyactis* is distinct from *L. himalayanum* and *L. jacotianum* due to papillate cypselas and smaller carpopodium and above two species have papillate-clavate cypsela surface but remain distinct from each other due to the diameter of carpopodium and its foramen. Similarly, the species of *Phagnalon* are also separated from each other on the basis of bristles structure and size of carpopodium. However, the cypsela characters are not helpful at infraspecific level as both the varieties of *Phagnalon schweinfurthii* i.e., var. *lamondae* and var. *androssovi*i have similar cypsela features. Therefore, from the foregoing discussion it is evident that all the taxa of the tribe Gnaphalieae can be easily delimited on the basis of cypsela features.

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