

SEM studies of Achenes in some taxa of Asteraceae

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Abstract

The present work studied the micromorphological characters of achenes in seven taxa of the family Asteraceae from Nagpur (M.S.) namely *Acanthospermum hispidum* DC., *Amberboa ramosa* (Roxb.), *Caesulia axillaries* (Roxb.), *Conyza aegyptiaca* Ait., *Pulicaria angustifolia* DC., *Spilanthes acmella* Linn. and *Synedrella vialis* (Less.). Dried, matured and healthy achenes were collected, measured, described and illustrated under light and scanning electron microscopy (SEM). Results obtained from this investigation showed diversity in colour, hilum, pappus, shape, size, spine, surface, and ribs. Achenes are conical in *Acanthospermum*

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hispidum DC.; *Synedrella vialis* (Less.); triangular in *Caesulia axillaries* (Roxb.), oblong in *Amberboa ramosa* (Roxb.), *Spilanthes acmella* Linn.; obovate in *Conyza aegyptiaca* Ait. and oblong-obovate in *Pulicaria angustifolia* DC.; hilum basal and lateral in *Amberboa ramosa* (Roxb.), basal and sublateral in *Conyza aegyptiaca* Ait. and basal in remaining taxa. Variations also observed in surface of achenes of different taxa. Surface spiny in *Acanthospermum hispidum* DC.; awns in *Caesulia axillaries* (Roxb.), *Synedrella vialis* (Less.); phyllaries in *Spilanthus acmella* Linn. and hairy in remaining taxa. Ribs are absent in all taxa except *Amberboa ramosa* (Roxb.). Micro and macro morphological similarities in structure of achene showed interspecies relationships and reasons for them to be placed in the same family and differences in them showed to exist as distinct species. These characters have been used to strengthen the systematic position of the taxa.

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Introduction

Taxa of the family Asteraceae are herbs, shrubs, rarely twiners or trees. The leaves are simple, alternate or opposite, rarely compound. The inflorescence is head or capitulum with involucre bracts. Marginal ray florets are ligulate and unisexual where as central disc florets are tubular and bisexual. Anthers syngenesious and basifixed. Ovary inferior, unilocular with one basal ovule. Fruit is of achene type or cypsela with persistent pappus (Dutta, 1974). The family Asteraceae is an advanced position in systematic botany. It is remarkable in many respects as it has number of species worldwide in distribution and effective mechanism of cross pollination. These characters occur in majority of plants but some variations have been recovered in large number of taxa. These variations led certain systematists to established division within the family. Pollen carries the male gamete of seed plants. This character attracted the attention of many scientists but scientists also used the seed (achene) morphology (Nyananyo, 1987; Nyananyo and Olowokudejo, 1986) to produce more acceptable classification of the species in taxa of Asteraceae. The achene characters of taxonomic value are shape, size, colour, surface, spine, pappus awns, phyllaries and hilum. Variations in these characters have been used in the delimitation of various taxa (Kynclova, 1970; Ritter & Miotlo, 2006; Abid and Zehra, 2007).

The present study is based on the hypothesis that achene characters played a vital role in the delimitation of various taxa but has not been to

delimit the seven taxa of Asteraceae studied by author. These characters are used for the establishment of interspecies relationships among the taxa investigated.

Material and Methods

Achene morphology of the seven taxa of Asteraceae was studied from Nagpur (M.S.). For morphological study fresh, mature, dried and healthy achenes were collected from different localities of Nagpur and kept in vials. For each taxon collector name and number is given (Appendix-I). When possible, upto four specimens were analyzed to confirm the obtained results. Morphological characters were examined under light and scanning electron microscope. Light microscopy has been carried out with the help of Leitz Ergaval microscope. For scanning electron microscopy dry achenes were directly mounted on aluminum stubs, vaccum sputtered and scanned at 10-20 kv. The scanning was done on Quanta 200, Neitherland available at Automotive Research Association of India (ARAI), Pune (Maharashtra). The following achene characters were studied:

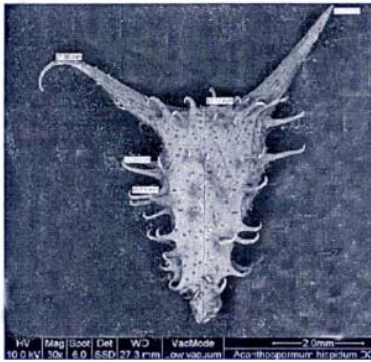
Observations

Acanthospermum Schranc.

Acanthospermum hispidum DC.

Achenes are 5x2mm, more or less conical, narrow at the base and broad at the apex, golden brown in colour, two long spines at the apex, between these spines present four small curved spines, surface covered with spines and on lateral surface long curved spines are present which septate, hilum basal.

SEM study reveals similar characters and few spines on lateral side, surface cellular, cells rectangular, small curved spines on the surface are directed upward, upper surface or curved spines smooth where as rectangular reticulum occur at base, small cavities present on the surface. (A, B, C)



A. *Acanthospermum hispidum* DC.
Achene



B. *Acanthospermum hispidum* DC.
Surface



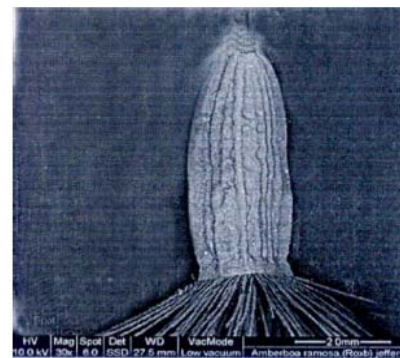
C. *Acanthospermum hispidum* DC.
Part of surface magnified

Amberboa (Pers.) Less. nom. cons.

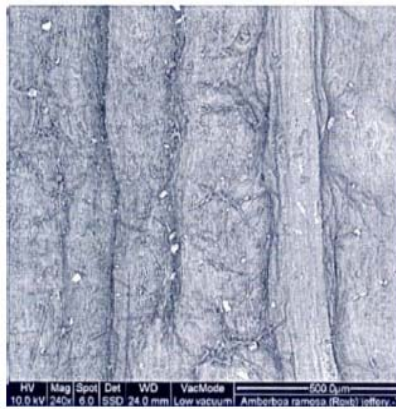
Amberboa ramosa (Roxb.)

Achenes are 5 – 6 x 2 mm, large, oblong, dark brown in colour, narrow at both the ends and swollen in the middle, many vertical ribs, pappus many, longer than achene, unequal in length, light brown at the base and silvery creamy coloured at the apex, lateral hairs on the pappus scattered, small hairs on the lateral side, small cavities on the surface, hilum basal and lateral.

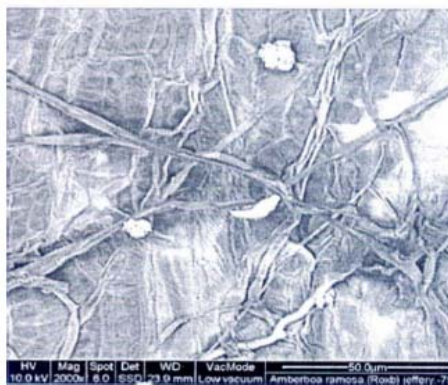
SEM study reveals that achenes are ribbed, oblong, narrow at both the ends and swollen in the middle, hilum basal and lateral, constriction at the apex, surface rugose, cellular, cells rectangular, septa not clearly demarcated, each cell has reticulate network representing cavities, deposition on the surface, pappus at the apex, longer than achene, pappus of two types: (i) long and thin (ii) long and broad. Long and thin pappus have small pappus hairs having pulvinous base, alternate, apex acute while long and broad pappus have parallel lines showing ridges and grooves, pappus hairs opposite, acute having prominent ridge. (D, E and F).



D. *Amberboa ramosa* (Roxb.) Jeffry
Achene



E. *Amberboa ramosa* (Roxb.) Jeffry



F. *Amberboa ramosa* (Roxb.)
Part of surface magnified

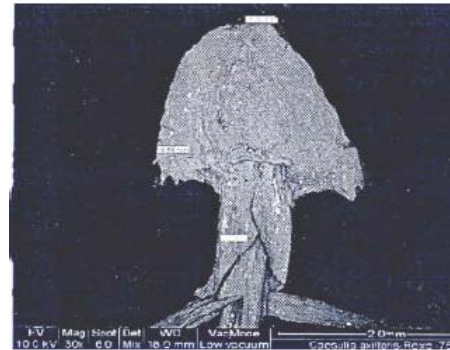
Caesulia Roxb.

Caesulia axillaries Roxb.

Achenes are 2 x 1.25 mm, medium sized, thin, epapose, flattened, dark brown in colour, triangular in shape, narrow at the base and broad at the apex, thin flattened flap like outgrowth on the lateral side, two long and few short awns at apex, hilum basal.

SEM study reveals that achenes are triangular, flattened, narrow at the base, broad and concave at the apex, hilum basal, surface cellular, cells rectangular, septa transverse, walls thin, reticulation occur in each cell, curved, irregular, small, thin, triangular outgrowth at the apex, from the lateral region of this septa secondary outgrowth developed,

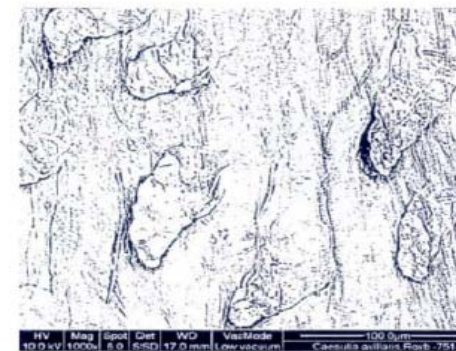
margin irregular, few patches on the surface (G, H & I)



G. *Caesulia axillaris* Roxb.
Achene



H. *Caesulia axillaris* Roxb.
Surface magnified



I. *Caesulia axillaris* Roxb.
Part of surface magnified

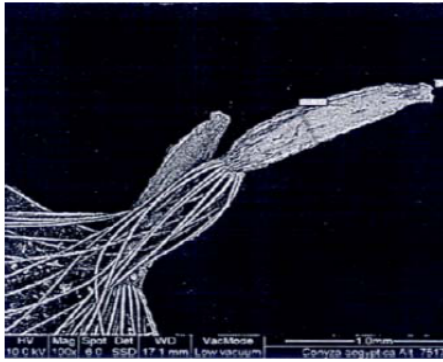
Conyza Less. nom. cons.

Conyza aegyptiaca Ait.

Achenes are 1.44 x 0.37 mm, small, flattened, thin, obovate, light brown in colour, surface

covered with thin, long hairs in upward direction, vertical ribs on the surface, pappus white, thin, longer than achene, unequal in length, lateral hairs on the pappus spirally arranged, reddish tinge at the apex of the hairs, hilum basal and sub lateral.

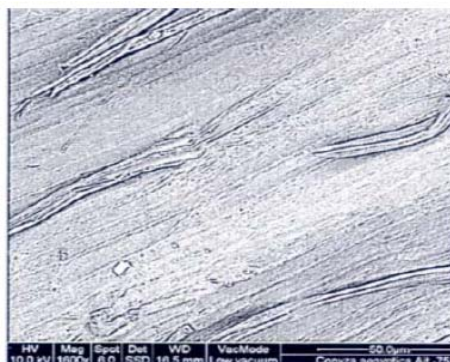
SEM study shows that achenes are thin, obovate, base narrow, constricted, hilum basal and sub lateral, apex concave, constriction occurs at the apex, surface cellular, cells thin rectangular with oblique septa, each cell thinly reticulated, hairs scattered on the surface are prominent, pair of hairs broad at the base, apex thin and acute, pappus thin, long, dark and light marking passing through the central region of the pappus, pappus hairs small, opposite, superposed, apex bright and obtuse. (J, K, L & M)



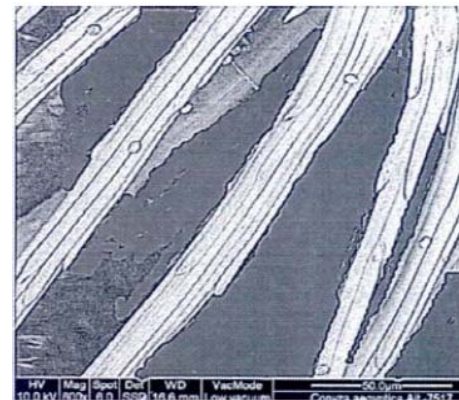
J. *Conyza aegyptiaca* Ait.
Achene



K. *Conyza aegyptiaca* Ait.
Surface magnified



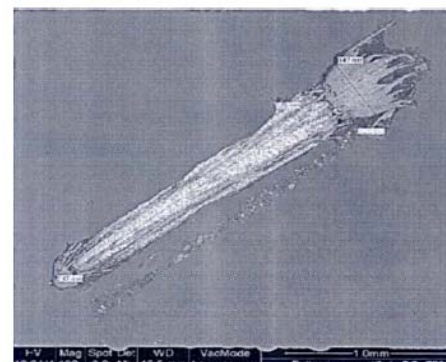
L. *Conyza aegyptiaca* Ait.
Part of surface magnified



M. *Conyza aegyptiaca* Ait.

Pulicaria Gaertn.

Pulicaria angustifolia DC.



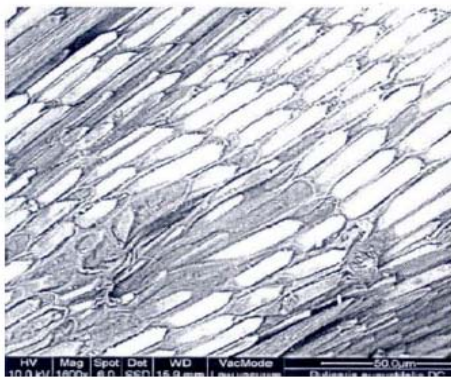
N. *Pulicaria angustifolia* DC.
Achene

Achenes are 2 x 0.96 mm, small, flattened, oblong-obovate, blackish brown in colour,

truncate at apex, covered with hairs, pappus white, longer than seed, unequal in length pappus forming a laciniate cup, reddish tinge and hilum basal.

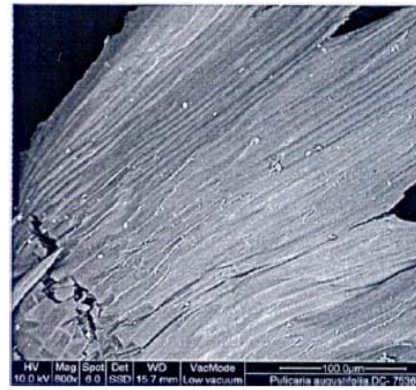


O. *Pulicaria angustifolia* DC.
Surface of Achene



P. *Pulicaria angustifolia* DC.
Part of Surface magnified

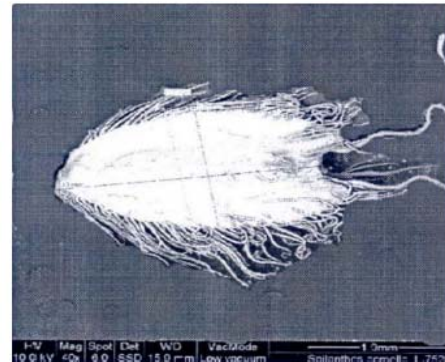
SEM study reveals that seeds are long, straight, oblong-obovate, hilum basal, prominent, constriction occur at the base, pappus developed on fringed laciniate cup shaped structure, surface cellular, cells are small, hexagonal with thin oblique septa, walls thin and each cells have a brightly embedded and protruded structure; thin long unicellular hairs scattered and embedded on the surface; pappus long, thin and hairy, pappus hairs lateral and parallel to the pappus. (N, O, P & Q)



Q. *Pulicaria angustifolia* DC. Anterior
Part of Achene

Spilanthus Jacq.

Spilanthus acmella Linn.



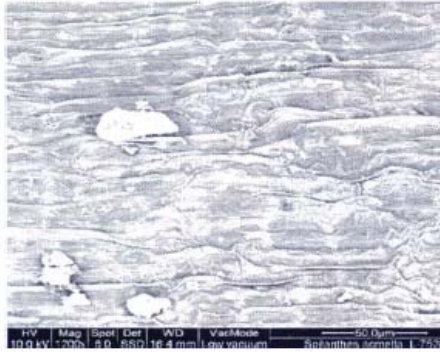
R. *Spilanthus acmella* Linn.
Achene



S. *Spilanthus acmella* Linn.
Surface of Achene

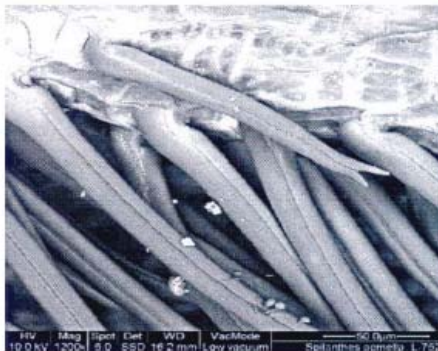
Achenes are 2.5 x 1.3mm, medium size, straight, oblong, black in colour, narrow at the base and broad at the apex, upward directed long brown hairs present on the lateral side,

these hairs are swollen at the base, two phyllaries of equal length present at the apex with notch and ridge in between the phyllaries, hilum basal.



T. *Spilanthus acmella* Linn. Part of Surface magnified

SEM study reveals that achenes are oblong, flattened, straight, hilum basal but not prominent, 'U' shaped notch developed between two long phyllaries at the apex, margin hairy; surface rough, cellular, cells are large, rectangular; walls thin, deposition of substances occur on the surface, hairy setae like structure develop from the lateral margin which is broad at the base, bifurcated and pointed at the apex; vertical rib developed from base to apex. (R, S, T, U)



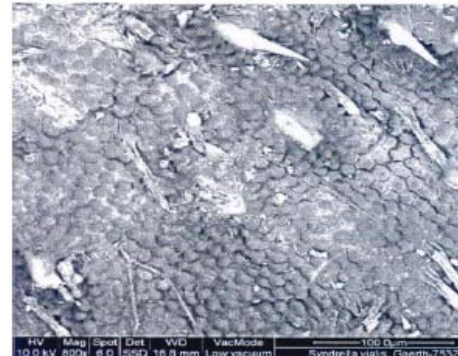
U. *Spilanthus acmella* Linn. lateral Part of Achene magnified

Synedrella Gaertn., (nom. cons.)

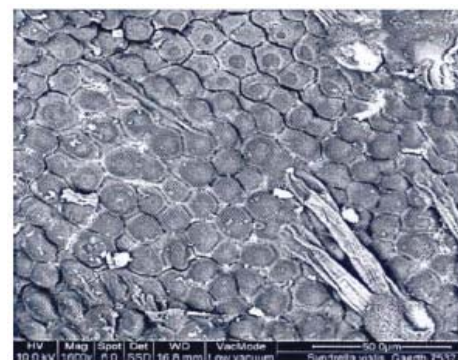
Synedrella vialis (Less).



V. *Synedrella vialis* Gaertn. Achene



W. *Synedrella vialis* Gaertn. Surface of Achene

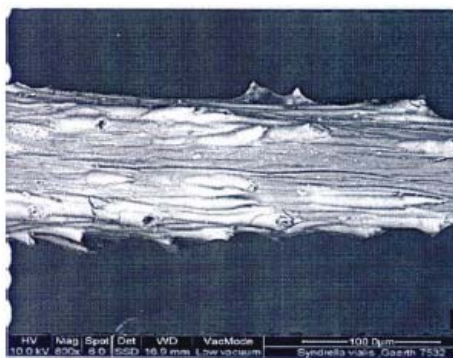


X. *Synedrella vialis* Gaertn. Part of surface magnified

Achenes are 4 x 1.5mm, long, conical or triangular, dark brown or light brown in colour, tapering at the base and broad at the apex, straight, spines like structure developed in

upward direction on lateral side, two long awns present at the apex with small hairs on it, surface hairy, hairs small, margin undulating, hilum basal, not prominent.

SEM study reveals that seeds are long, conical or triangular, tapering at the base and broad at the apex, straight, hilum basal, not prominent, surface hairy, hairs are small, apex bright and pointed, two long unequal awns at the apex, surface cellular, cells small, hexagonal looks like honey comb, small, pointed, bright hairs protrude from the hexagonal cell surface, few cells show cavity like structure, awns consist of small rectangular cells, surface hairy, apex blunt. (V.W.X.Y).



Y. *Synedrella vialis* Gaertn.
Part of awn magnified.

Discussion and Conclusion

Most of the tribes of the family Asteraceae have quite similar achene characters with the exception of Helianthae, Eupatorieae and Inuleae (Abid and Qaiser, 2007, 2008, 2009). These characters are found taxonomically significant both at generic and species levels which play an important role in demarcating definite evolutionary level. These characters have also been used to strengthen the systematic position of the taxa. In the present

study micro-morphological characters of achene shows wide variations in seven different taxa of Asteraceae (Table-1). Hence, delimitation of taxa is difficult. Except *Acanthospermum hispidum*, *Caesulia axillaries* and *Synedrella vialis* in remaining taxa achene shape is oblong, obovate and oblong-obovate (Jayanarayanan and Manilal, 1998; Saklani et al., 2000; Abid and Qaiser, 2007, 2008; Abid and Ali, 2010). Mature achenes are hairy in *Conyza aegyptiaca*, *Pulicaria angustifolia*, *Spilanthes acmella* and *Synedrella vialis* except in *Acanthospermum hispidum*, *Amberboa ramosa*, *Caesulia axillaries*. Achenes are ribbed in *Amberboa ramosa* and *Conyza aegyptiaca* as reported by Anderberg (1991). In *Acanthospermum hispidum* surface of achene is spiny which shows structural adaptation for effective dispersal by animals. Awns are present in *Caesulia axillaries* and *Synedrella vialis* where as phyllaries are present in *Spilanthes acmella*. These are dependable characters for identification of taxa (Jayanarayanan and Manilal, 1998). Achenes are epapose in *Acanthospermum hispidum*, *Caesulia axillaries* and *Spilanthes acmella* but pappus of unequal length and varying colour present in *Amberboa ramosa*, *Conyza aegyptiaca*, *Pulicaria angustifolia* (Table-1), (Paria and Chinya, 1998; Abid and Qaiser, 2007, 2009; Abid and Zehera, 2007 and Swelankomo, et al, 2007). This is also a structural adaptation for effective dispersal by wind which plays important role in world wide distribution of taxa. Hilum basal in all taxa except in *Conyza aegyptiaca* and *Amberboa ramosa* (Singh and Pandey, 1981; Pandey et al., 1983; Abid and Qaiser, 2007; Abid and

Ali, 2010 and Shekher *et al.*, 2011). In the present work SEM characterization of achene surface also show variations in seven taxa of Asteraceae. Cell hexagonal with oblique septa observed in *Conyza aegyptiaca*, honey comb like hexagonal cell in *Synedrella vialis* and rectangular type of cells in all other taxa of present work (Abid and Quaiser, 2008; Abid and Ali, 2010). These characters have little influence upon the shaping of classification. Micro and macro morphological similarities in structure of achene showed interspecies relationships and reasons for them to be placed in the same family and differences in them showed to exist as distinct species. Different morphological characters also show structural adaptation for effective dispersal mechanism by different agencies. All micro morphological characters in the present work play an important role in demarcating definite evolutionary level which has been used to strengthen the systematic position of taxa.

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Characters	Name of Taxa						
	<i>Acanthospermum hispidum</i> DC.	<i>Amberboa ramosa</i> (Roxb.)	<i>Caesulia axillaries</i> Roxb.	<i>Conyza aegyptiaca</i> Ait.	<i>Pulicaria angustifolia</i> DC.	<i>Spilanthus acnella</i> Linn.	<i>Synedrella vialis</i> (Less).
Shape	Conical	Oblong	Triangular	Obovate	Oblong-obvate	oblong	Conical or triangular
Size	5x2mm	5-6x2mm	2x1.25mm	1.44x0.37mm	2x0.96mm	2.5x1.3mm	4x1.5mm
Colour	Golden brown	Dark brown	Dark brown	Light brown	Blackish brown	Black	Dark and light brown
Surface	Cellular, spiny	Hairy, cellular, cells rectangular	Hairy, cellular, cells rectangular	Hairy, cellular, cells rectangular with oblique septa	Hairy, cellular, cells hexagonal with oblique septa	Hairy, cellular, large rectangular cells	Hairy, cellular, cells hexagonal (honey comb like)
Spine	Curved, septate; 2-long and 4-small spines at the apex	-	-	-	-	-	-
Awn	-	-	2-long and few short awns present	-	-	-	2-long unequal awns present
Phyllaries	-	-	-	-	-	2, equal, U-shaped notch between the two phyllaries	-
Pappus	-	Many, unequal, light brown at the base and silvery creamy at the apex.	Epapose	White, unequal with reddish tinge at the apex	White, unequal with reddish tinge, laciniate cup	-	-
Hilum	Basal	Basal and lateral	Basal	Basal and sub-lateral	Basal	Basal	Basal(not prominent)
Ribs	-	Many vertical ribs	-	Vertical ribs	-	-	-

Table 1: Achene characters in some taxa of Asteraceae

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