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Research Article

SCANNING ELECTRON MICROSCOPIC STUDIES OF CYPSELA SURFACE IN SOME SPECIES OF TRIBE EUPATORIAE (ASTERACEAE)

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ABSTRACT
Surface patterns of Sypselasin five species viz., *Ageratum conyzoides, A. houstonianum, Eupatorium cannabinum, E. purpureum* and *E. urticaefolium* belonging to tribe Eupatoriae of family Asteraceae were studied. The five species showed significant differences in the primary structure and revealed irregular reticulate, pronounced undulated, ribbed and beaded striated reticulate types of primary sculpture. The secondary sculpture was of smooth rugose, smooth pitted and smooth to slightly wrinkled types. A cap-like carpopodium was seen in the two species of *Ageratum* while it was absent in the three species of *Eupatorium*.

Keywords: *Cypsela, Spermodern Patterns, Primary Sculpture, Secondary Sculpture, Carpopodium*

INTRODUCTION
Barthlott (1984) stated that seed surface features are little affected by the environmental conditions and seem to reflect genetic and phylogenetic differences in the plants concerned.
Earlier Heywood (1971) drew attention to the importance of impact of SEM in the study of systemic problems. During the past 4-5 decades several papers appeared on the analysis of seed coat observed under SEM.
In the light of importance of seed (Cypselahere) surface, it was planned to undertake the SEM studies of cypselas in the important family asteraceae. The present report forms part of this wider investigation.

MATERIALS AND METHODS
The following five species were undertaken for SEM studies of cypselas

1. *Ageratum conyzoides* L.
2. *Ageratum houstonianum* Mill.
3. *Eupatorium cannabinum* L.
4. *Eupatorium purpureum* L.
5. *Eupatorium urticaefolium* Reichard

The mature dried cypselas of these species were prepared for SEM analysis. The cypsellas were affixed on aluminium stubs with the help of transparent adhesive. These were then coated with gold and examined at a range of magnifications in a Leo 435 VP Scanning Electron Microscope at AIIMS, New Delhi, India.

The terminology like primary and secondary sculptures and different types of SEM patterns like reticulate, smooth, pitted, beaded, striated, undulated etc. used in the text are slightly modified from those used by earlier workers (Barthlott, 1981; Hufford, 1995; Mukherjee, 2000; Johnson *et al.*, 2004).

RESULTS
The details of cypsela shape, size, colour and spermodern patterns etc. observed are described separately for each species studied here.

Ageratum Conyzoides (Figure 1A-C)

Size: The size of cypsela varies from 1.5 to 2.0 mm in length and 0.4 to 0.6 mm in breadth

Shape: Quadrangular

Colour: Black

Pappus elements - Awned scales

Spermodern pattern - Primary sculpture appears to be irregular reticulate. Cell shapes are unclear, as anticlinal walls are undulated and slightly raised. Some waxy depositions are also seen on the surface. Periclinal walls are nearly flat and secondary sculpture is rugose type. Cap like carpopodium is present in the form of complete ring.

Ageratum Houstonianum (Figures 1D-F)

Size: Cypsela size varies from 2.0 to 2.2 mm in length and 0.6 to 0.8 mm in breadth

Shape: Oblong cylindrical with blunt beak shaped hilum

Colour: Black

Pappus elements - Awnless, triangular scales are coroniform. Occasionally pappus are absent at maturity.

Spermodern pattern - Spermoderm exhibits pronounced waxy undulations. The undulations are characterized by regular disposed crests and troughs. The surface of the crests and troughs shows subsidiary minor projections as seen in high magnification. The anticlinal walls are undulated and distinctly raised with depressed periclinal walls. Transverse walls depressed deep in the middle region so that the shape of cell is not clear. However cell boundary can be made out as the joints of transverse and anticlinal walls are very clear. Needle-like hair with a broad base and blunt tip on crest ends are also seen here and there. Secondary sculpture is smooth pitted. Cap like carpopodium is present.

***Eupatorium Cannabinum* (Figures 2 A-C)**

Size: Cypsela measures about 2.0 to 2.1 mm in length and 0.9 to 1.0 mm in breadth

Shape: Oblong cylindrical with somewhat pointed tip

Colour: Black

Pappus elements - Long hairy scabrous barbellate bristles

Spermodern pattern - Primary sculpture appears to be irregular reticulate having more or less rectangular cells. Anticlinal walls are more or less straight and distinctly raised as compared to transverse walls. Flake like waxy depositions are also seen. Periclinal walls are flat to concave and secondary sculpture is nearly smooth. Carpopodium is not clear.

***Eupatorium Purpureum* (Figures 2 D-F)**

Size: Cypsela size varies from 3.0 to 3.1 mm in length and 0.6 to 0.7 mm in breadth.

Shape: Oblong cylindrical with four edges and acute hilum

Colour: Black

Pappus elements - Scabrous barbellate bristles

Spermodern - It is ribbed. The ribs (anticlinal walls) are almost perpendicular to the longitudinal axis of the cypsela and parallel to each other and sometimes forming groups of 4 to 12 string like structures. Interconnections between adjacent anticlinal walls are not clear. Secondary sculpture is smooth. Carpopodium is not seen.

***Eupatorium Urticaefolium* (Figures 3 A-D)**

Size: Cypsela size varies from 2.0 to 2.2 mm in length and 0.7 to 0.8 mm in breadth

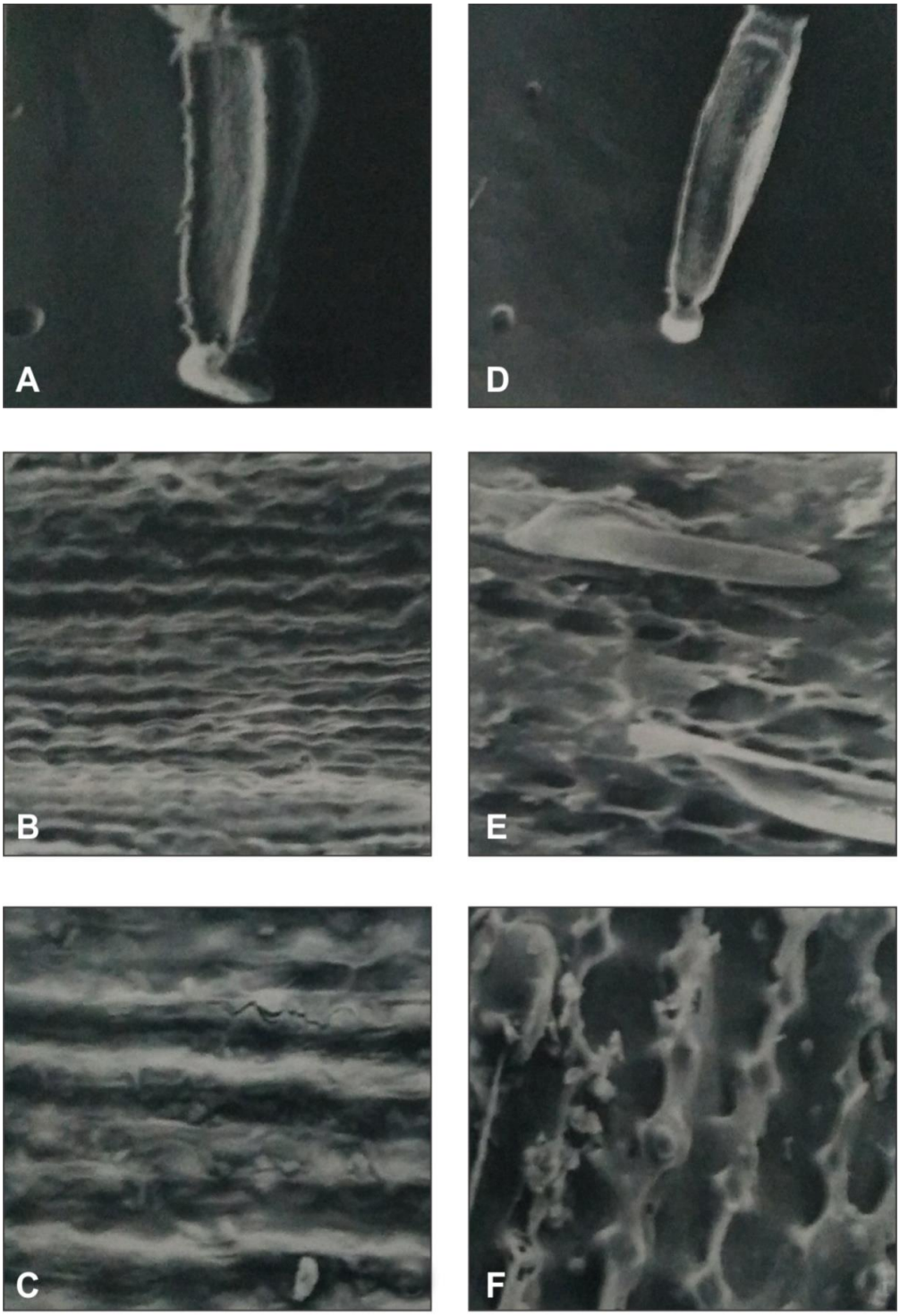
Shape: Oblong cylindrical with narrowing tip forming a bead like structure. Four longitudinal ribs at equidistance can be seen on the surface.

Colour: Black

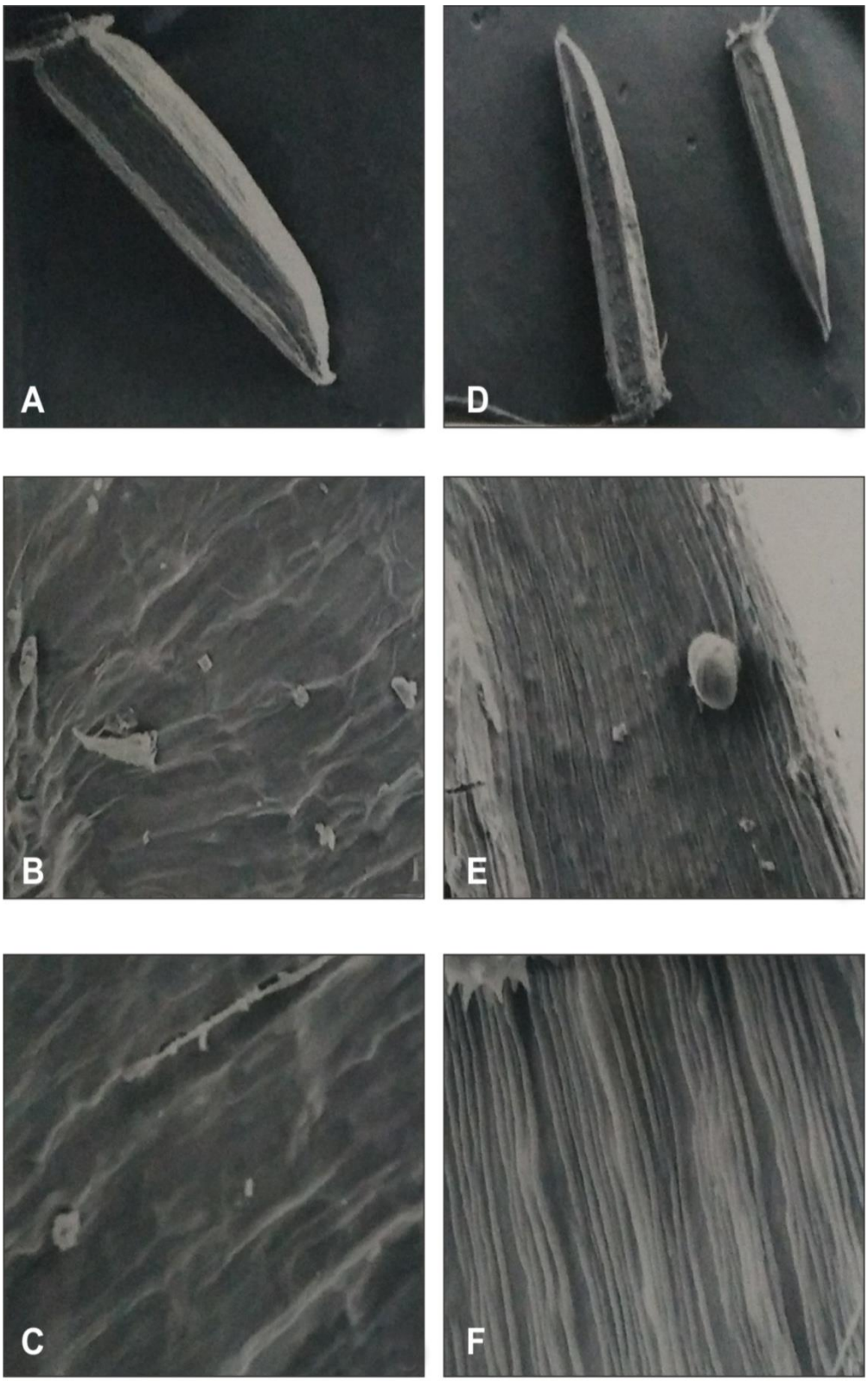
Pappus elements - Scabronsbarbellate bristles

Spermodern pattern - The spermodern shows beaded striated reticulate appearance, having rectangular cells. In primary sculpture, anticlinal walls are seen straight and distinctly raised and periclinal walls are flat to nearly convex. Small rounded out growths on the anticlinal walls give them beaded appearance. These outgrowths are also visible on periclinal walls of higher magnification. The apical portion of the

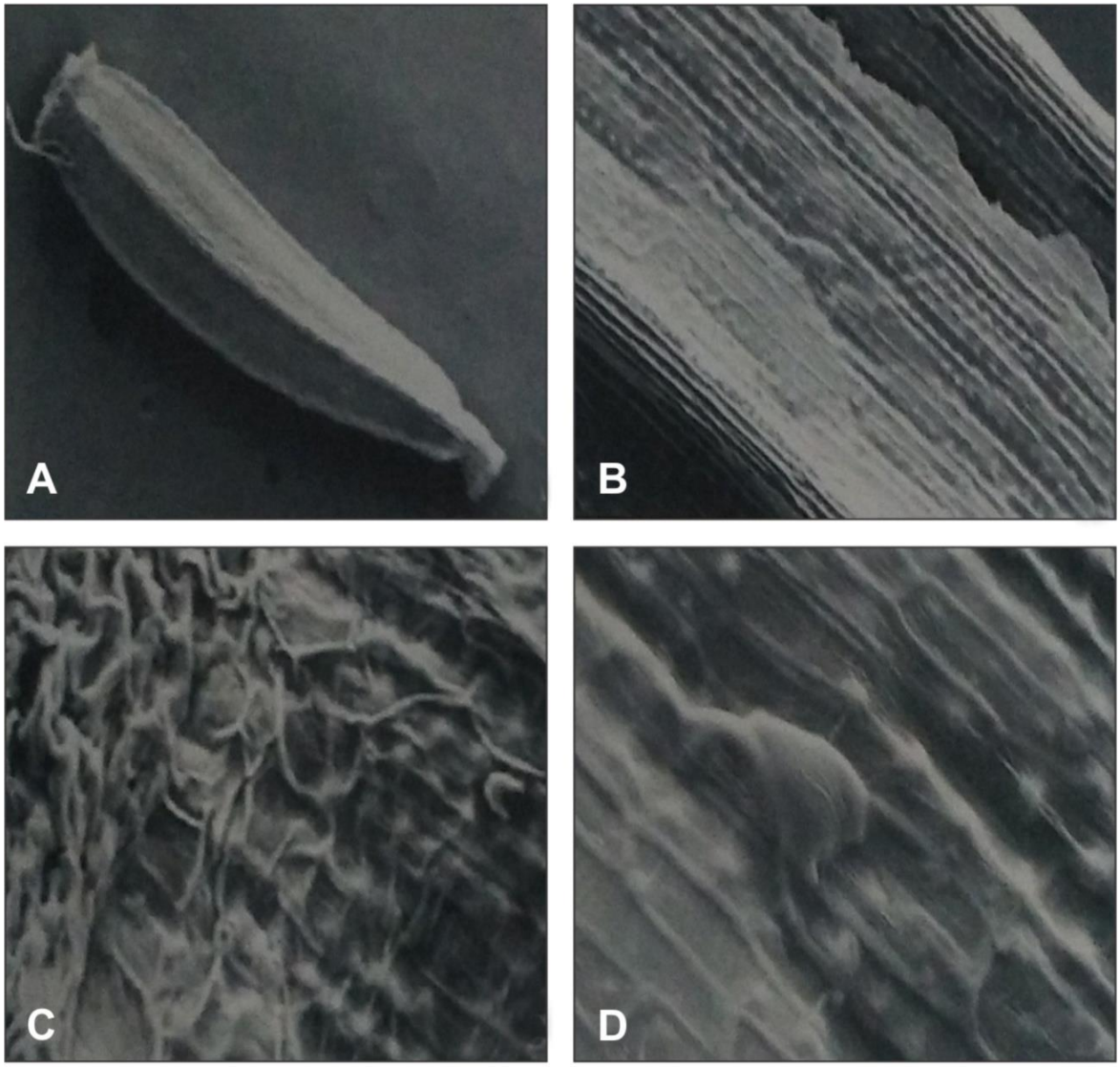
cypsela shows a compact network of ridges and furrows to form polygonal areas. Secondary sculpture is smooth to slightly wrinkled. Carpopodium is not seen.



Figures 1 A-F: Cypsela and spermodern patterns in *Ageratum conyzoides* and *Ageratum houstonianum*
A - Cypsela, x 60; B - Surface, x 600; C - Surface, x 1000
D - Cypsela, x 30; E - Surface, x 300; F - Surface, x 600



Figures 2 A-F: Cypsela and spermodern patterns in *Eupatorium cannabinum* and *Eupatorium purpureum*
A - Cypsela, x 40; B - Surface, x 500; C - Surface, x 1000
D - Cypsela, x 20; E - Surface, x 300; F - Surface, x 2000



Figures 3 A-D: Cypsela and spermodern patterns in *Eupatorium urticaefolium*
A - Cypsela, x 40; B - Surface, x 300; C - Surface, x 600
D - Surface, x 1000

DISCUSSION

Mukherjee and Sarkar (1994) underlined the taxonomic applicability of structure of trichomes, carpopodium, pappus, mucilage cells and crystals etc. Basak and Mukherjee (2003) concluded that diacritical features of cypselas played a paramount role in isolation of taxa at the species level. The data gathered on morphological and scanning electron microscopic sculptures of the cypsela surface in five species of eupatoriae are in agreement with these observations.

The characteristics like average size, shape and colour of cypselas studied here are also species specific and useful in identification of the taxa. These characteristics alongwith the spermodern patterns revealed by the light and scanning electron microscopy are significant in relating the taxa with each other within the tribe and with taxa of the other tribes of the family Asteraceae. The data support Brietwieser and Ward's (2003) observations that the wide variations in cypsela size and shape, configuration of the surface cells and structure of the twin hairs and pappus must be potentially valuable for uncovering evolutionary pathways.

The primary sculptures in *Ageratum conyzoides, A. houstonianum, Eupatorium cannabinum, E. purpureum* and *E. urticaefolum* showed irregular reticulate, pronounced undulated, irregular reticulate, ribbed and beaded striated reticulate types respectively. Mukherjee and Sarkar (1994, 1997, 2001), Garg and Sharma (2005, 2007) have also categorised the primary sculptures of cypsela in Asteraceae. The five taxa studied here revealed four species specific spermodern patterns based on the structure of anticlinal and periclinal walls and waxy depositions etc. The striated reticulate pattern was considered to be the basic type in the family Asteraceae by Garg and Sharma. Kothari (2009) also reported this pattern in twenty one species of Asteracae. The two species of *Ageratum*(*A. conyzoides* and *E. cannabinum*) studied here showed irregular reticulate type and indicate that there exist different types of reticulate patterns in the primary sculptures in Asterceae. The presence of smooth, rugose, smooth pitted and smooth to slightly wrinkled types of secondary sculptures reported here are also species.

Corpopodium is a structure of significance in Asteraceae. It is found as a cap-like structure in the two species of *Ageratum* while altogether absent in the three species of *Eupatorium* indicating that this structure could be a diagnostic feature at genus level.

Benthem and Hokker (1873) realising importance of pappus structure during the treatment of *Ageratum* included a discussion of the genus and variations in the pappus. There is a diversity in details of pappus structure in different species studied here and this is in support of Kshetrapal *et al.*'s (2000) observation that presence of pappus is a unique feature of the compositae.

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