ANATOMY OF SEEDS AND FRUITS IN SOME ASTEREAE (COMPOSITAE)

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ABSTRACT

Anatomy of seeds and fruits in 10 taxa of the tribe Astereae of the family Compositae has been studied. The pericarp is well-differentiated anatomically and the pattern of differentiation is of some taxonomic value. Seed coat is single-layered except in *Conyza bonariensis* where it is represented by a noncellular pellicle. A single layer of endosperm persists in mature seeds.

INTRODUCTION

Exomorphic characters of cypsela have been applied for identification purposes in conventional taxonomic descriptions of Compositae, but on the contrary not much attention has been paid to utilise the anatomical structure of seed coat and fruit wall for this purpose. Present investigation, therefore, describes anatomy of seeds and fruits in *Aster amellus* L., *A. foliaceus* Lindl., *A. macrophyllus* L., *A. rotundifolius* Thunb., *A. tongalensis* Franch., *Callistephus chinensis* Nees., *C. hortensis* Cass., *Conyza bonariensis* L., *Felicia heterophylla* Grau, and *Solidago virgaurea* Auct.

MATERIAL AND METHODS

Mature cypsils were obtained from the seed herbarium of National Botanical Research Institute, Lucknow. Customary methods of dehydration in tertiary butyl alcohol and embedding in paraffin wax were followed. Microtome sections were cut at a thickness of 10-15 μm. Sections were stained in safranin- fastgreen combination.

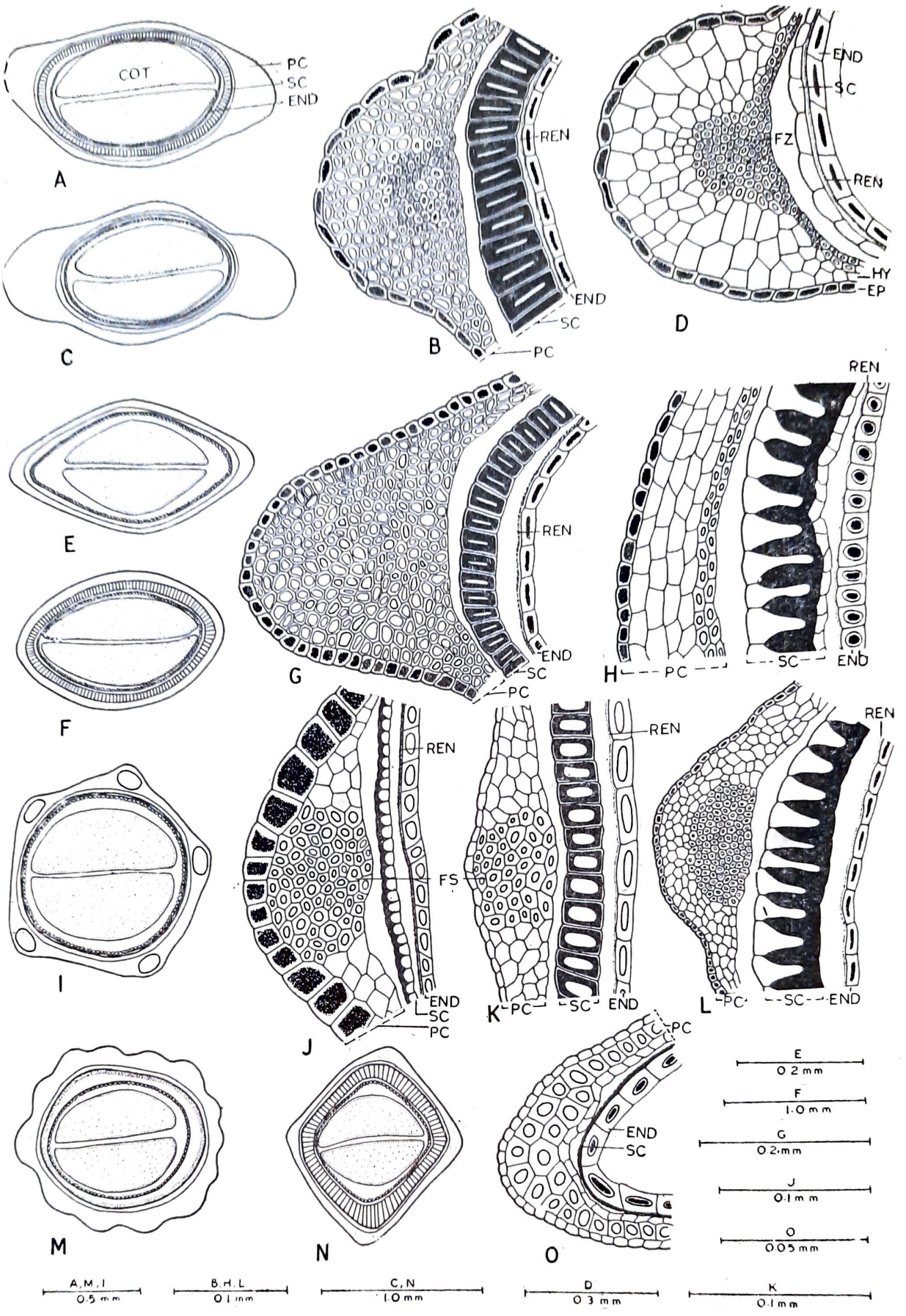
OBSERVATIONS

Aster

Fruit—The fruits are light to dark brown in *A. amellus*, *A. macrophyllus*, brown in *A. foliaceus* and brown to black in *A. rotundifolius* and *A. tongalensis*. The fruits are flat and oval in outline. These are distinguishable into a lighter peripheral and darker central regions, and are hairy in *A. amellus* and *A. foliaceus* only. At the base of the fruit there is a foveole surrounded by a cream-coloured ring and this shows place of attachment of the cypsela. In *A. amellus* and *A. foliaceus*, pappus is made up of thin whitish hairs while in other species there is a ring of whitish tissue at the top of the fruit.

Pericarp—Cross-sections of mature fruits show nearly elliptical outline in *A. amellus*, *A. foliaceus*, *A. rotundifolius* and *A. tongalensis* (Fig. 1A) but the fruit is pentagonal in outline in *A. macrophyllus* (Fig. 1 I). The pericarp of the former four species differs from the last species and are, thus, described separately.

Anatomically, the pericarp in *A. amellus*, *A. foliaceus*, *A. rotundifolius* and *A. tongalensis* is distinguishable into two zones. The outerzone is constituted by a layer of thin-walled epidermal cells containing some brownish substance while the inner zone is made



Taxa of tribe Astereae. Anatomy of mature cypsils.

Text-figs. 1 A—O. A. C. s. mature cypsela of *Aster amellus*, B. C. s. part of same magnified, C. C. s. of mature cypsela of *Felicia heterophylla*, D. A part of same magnified, E. C. s. mature cypsela of *Conyza bonariensis*, F. C. s. of mature cypsela of *Callistephus hortensis*, G. C. s. part of mature cypsela of *Aster tongalensis*, H. C. s. part of mature cypsela of *Callistephus hortensis*, I. C. s. mature cypsela of *Aster macrophyllus*, J. C. s. part of mature cypsela of *Solidago virgaurea*, K. C. s. part of mature cypsela of *Aster macrophyllus*, L. C. s. part of mature cypsela of *Callistephus chinensis*, M. C. s. mature cypsela of *Solidago virgaurea*, N. C. s. mature cypsela of *Callistephus chinensis*, O. C.s. part of mature cypsela of *Conyza bonariensis*.

(COT—cotyledon, END—endosperm, EP—epidermis, FS—fibrous strand, HY—hypodermis, PC—pericarp, REN—remnants of endothelium, SC—seed coat).

up of many layers of sclerosed cells (Fig. 1 B, G). In *A. macrophyllus* fibrous strands are situated at five places in the pericarp (Fig. 1 I). These strands are made up of thick-walled sclerenchymatous cells (Fig. 1 K). Besides fibrous strands, the pericarp is distinguishable into two zones, (*a*) a layer of epidermis made up of thin-walled cells, and (*b*) a few layers of thin-walled tissue (Fig. 1 K).

Seed coat—Only a single layer of seed coat persists in the mature seed(Fig. 1 B, G, K). The cells of the seed coat are radially elongated and conspicuously thickened uniformly. They stain red with safranin. The endothelium is seen as a noncellular pellicle (Fig. 1B, G, K).

Endosperm and embryo—In the mature seed, only the outermost layer of the endosperm persists (Fig. 1 B, G, K). The cells of the endosperm become thick-walled in *A. foliaceus* and *A. macrophyllus* while they remain thin-walled in rest of the species. The mature embryo occupies entire length of the seed.

Callistephus

Fruit—The fruits are oblong, hairy and dark brown. At the base of the fruit, a foveole is present which is surrounded by a ring. The pappus is absent.

Pericarp—Cross-section of a mature fruit shows nearly elliptical outline in *C. hortensis* (Fig. 1 F) and quadrangular in *C. chinensis* (Fig. 1 N). Anatomically, the pericarp in both the species is different, hence they are described separately.

In *C. hortensis*, the pericarp is differentiated into three distinct zones, (*a*) the outer zone is made up of a layer of epidermis whose cells contain dark brown substance, (*b*) the middle zone is composed of thin-walled cells and (*c*) the inner zone is formed of two layers of thick-walled sclerenchymatous cells (Fig. 1 H).

In *C. chinensis*, the pericarp is mainly differentiated into two zones, (*a*) a layer of epidermis whose cells contain dark brown substance, and (*b*) a few layers of thin-walled cells. At the four corners in the pericarp, fibrous strands are composed of thick-walled sclerenchymatous cells (Fig. 1 L).

Seed coat—In mature seed, the seed coat is two-layered in *C. hortensis* (Fig. 1 H) and one-layered in *C. chinensis* (Fig. 1 L). The epidermal cells of seed coat in both the species are radially elongated and their 3/4 part of radial and entire inner tangential walls are thickened (Fig. 1 H, L). This thickened part takes deep stain with safranin. In *C. hortensis*, the subepidermal layer of seed coat remains thin-walled. The endothelium is represented by a thin cuticular layer (Fig. 1 H, L).

Endosperm and embryo—Only a single layer of endosperm persists in the mature seed (Fig. 1 H, L). The mature embryo occupies whole length of the seed.

Conyza

Fruit—The fruits are small, compressed and cream-coloured. The hairs are present throughout the length of the fruit. At the base of the fruit a foveole is present which is surrounded by creamish ring. The pappus is composed of hairs whose length is 3 to 4 times more than the main body of the fruit.

Pericarp—Cross-section of mature fruit shows more or less elliptical outline (Fig. 1 E). Anatomically, the pericarp is differentiated into three distinct zones, (*a*) a single layer of epidermis, (*b*) the second zone is made up of thick-walled sclerenchymatous cells, and (*c*) the third zone is composed of a single layer of thin-walled cells, and this forms the inner lining layer of the pericarp (Fig. 1O).

Seed coat—Seed coat in a mature seed no more remains in cellular form and is seen as a thick brown pellicle closely adpressed to the persisting layer of the endosperm (Fig. 10).

Endosperm and embryo—A single layer of endosperm persists in the mature seed. The endosperm cells are considerably thickened. The mature embryo occupies whole length of the seed.

Felicia

Fruit—Colour of the fruit varies from light to dark brown. Under a stereoscopic binocular, the fruit is distinguishable into two zones—the outer is light brown in colour and forms the wing-like structure ; the inner zone is a dark brown biconvex structure which encloses the seed. The fruit is hairy. At the base of the fruit, there is a foveole which is surrounded by a whitish ring and this shows the place of attachment of cypsela. A similar ring is seen on the top of the fruit also and the pappus is absent.

Pericarp—Cross-section of a mature fruit shows an oval central region with two inflated sides (Fig. 1 C). Anatomically, the pericarp is distinguishable into following three zones, (*a*) epidermal layer of thin-walled cells containing a dark brown substance, (*b*) the middle zone is made up of thin-walled cells whose number varies. On the swollen sides, the number is larger, (*c*) the inner zone is made up of thick-walled sclerenchymatous cells and forms the main mechanical zone in the pericarp (Fig. 1 D). The number of sclerenchymatous cells is more in swollen regions.

Seed coat—Only a single layer of seed coat persists in the mature seed (Fig. 1 D). No thickening of any type is seen in the cells of the seed coat. The endothelium is seen as a noncellular pellicle (Fig. 1 D).

Endosperm and embryo—In the mature seed, only a single layer of endosperm persists (Fig. 1 D). The mature embryo occupies the entire length of the seed.

Solidago

Fruit—The fruits are narrow towards base and broad on stylar side. The colour of the fruit is dark brown. The fruit surface is hairy and the fruit shows ridges and furrows. At the base of the fruit a foveole is present which is surrounded by a whitish ring of thick-walled cells. Pappus is absent but at the top of the fruit there is an annular ring of brownish tissue.

Pericarp—Mature fruit in a cross-section is nearly circular in outline with distinct ridges and furrows (Fig. 1 M). Anatomically, the pericarp is differentiated into the following zones in the region of ridges, (*a*) a layer of large somewhat radially elongated epidermal cells containing a dark brown substance, (*b*) the second zone is made up of thick-walled sclerenchymatous cells forming a fibrous strand. Besides these thickened strands rest of the cells of the pericarp below the ridges are made up of thin-walled parenchymatous cells (Fig. 1 J). Below the furrows no sclerenchymatous strand is formed and the number of parenchymatous layer is also reduced to one.

Seed coat—In mature seeds, the seed coat is formed of the outer epidermis of the integument, and the outer tangential and radial walls of the epidermal cells are conspicuously thickened (Fig. 1 J). The endothelium is seen as a thin noncellular pellicle.

Endosperm and embryo—A single layer of endosperm persists in the mature seed (Fig. 1 J). The cells of the endosperm are considerably thickened. The number of endosperm cells is, however, more on the radicular end of the embryo. The mature embryo occupies a major part of the seed.

Table-1—Size of cypsela, length of embryo, hypocotyl-root-axis and cotyledons (measurements in mm)

Species	Cypsela l×b	Embryo	Hypocotyl-root-axis	Cotyledons
1. *Aster amellus* ..	2.5—4×1.5—2 ..	2.30	0.70	1.60
2. *Aster macrophyllus* ..	4—5×1 ..	3.15	1.15	2.00
3. *Aster foliaceus* ..	2.5—5×1.5—2.5 ..	2.10	0.90	1.20
4. *Aster rotundifolius* ..	3—3.5×1.5—2.5 ..	2.50	0.74	1.76
5. *Aster tongalensis* ..	5—5.5×1.5—2 ..	1.80	0.65	1.15
6. *Callistephus chinensis* ..	4—5×1.5—2 ..	3.30	1.06	2.24
7. *Callistephus hortensis* ..	4—4.5×1.5—2.5 ..	3.12	1.00	2.12
8. *Conyza bonariensis* ..	1.5—2.5×0.5 ..	1.20	0.50	0.70
9. *Felicia heterophylla* ..	4—5×1.5—2.5 ..	2.56	1.03	1.53
10. *Solidago virgaurea* ..	4—5×1 ..	3.00	0.90	2.10

DISCUSSION

The pericarp of the presently investigated taxa does not follow exactly similar pattern of differentiation and can be easily grouped in four categories: (i) In *Aster amellus*, *A. foliaceus*, *A. rotundifolius* and *A. tongalensis* the single-layered epidermis is followed by a multilayered thick-walled zone, (ii) In *Callistephus hortensis* and *Felicia heterophylla*, the epidermis is followed by a parenchymatous zone which is again followed by a zone of thick-walled cells, (iii) In *Aster macrophyllus*, *Callistephus chinensis* and *Solidago virgaurea*, the epidermis is followed by parenchymatous zone which includes fibrous strands at places, (iv) In *Conyza bonariensis*, the epidermis is first followed by a sclerenchymatous zone which is followed by a layer of parenchymatous cells. In other Astereae, viz., *Erigeron bonariensis* (SEHGAL, 1966), *Erigeron canadensis* (PANDEY, 1977) and *Conyza stricta* (PULLAIAH, 1978), the mature pericarp is represented by a layer of epidermis followed by a few subepidermal layers. As our existing knowledge on the pericarp structure of the members of this tribe is meagre, nothing can be said at the moment regarding the taxonomic significance of pericarp structure for the tribe Astereae.

The structure of the mature seed coat shows interesting variations in presently investigated taxa. In *Conyza bonariensis* (present study) the seed coat is reduced to a noncellular pellicle, a feature also reported in other Astereae, viz., *Erigeron bonariensis* (SEHGAL, 1966), and *Erigeron canadensis* (PANDEY, 1977). On the other hand, in *Conyza stricta* (PULLAIAH, 1978), the seed coat is represented by a single layer of thin-walled cells, an observation also made in *Felicia heterophylla* (present study). In contrast to the above, the cells of the seed coat epidermis show radial elongation in *Aster* species and *Callistephus* species. In *Aster* species, the epidermal cells of the seed coat are uniformly thickened but in *Callistephus* species, only inner tangential and to some extent the radial walls are thickened. In *Solidago virgaurea*, the outer tangential and to some extent the radial walls are thickened. Radial elongation and thickening of the epidermal cells of the seed coat have been reported in the members of tribe Cynareae (PANDEY & SINGH, 1977).

Based on this feature of seed coat, it is probable that Astereae might have links with Cynareae.

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