

MORPHO-ANATOMICAL FEATURES OF CYPSELAS IN SOME SPECIES OF THE TRIBE COREOPSIDEAE (ASTERACEAE)

*BIDYUT KUMAR JANA AND SOBHAN KR MUKHERJEE

Taxonomy and Biosystematics Laboratory, Department of Botany,
University of Kalyani, Kalyani-741235, Nadia, West Bengal, India
Email: janabidyutkumar@yahoo.com, sobhankumar@yahoo.com

ABSTRACT

Cypselar morpho-anatomy is very helpful for the separation of taxa in fruting stage. For this purpose, three species of the tribe Coreopsidae have been studied to separate the taxa more clearly. Morphologically, cypselas are either homomorphic (*Bidens cernua* and *Cosmos sulphureus*) or heteromorphic (*Bidens pilosa*). In *Cosmos sulphureus*, pappus is absent. Whereas in others, pappus is present. Pappus is represented by retrorsely barbed awn-like structure. In *Cosmos sulphureus*, stylopodium is enlarged, knob like structure whereas in the remaining, stylopodia are prominent but not enlarged. In cypselas, carpodia are symmetric and carpodial cells are arranged in 1-3 rows. Anatomically, in all the studied cypselas, phytomelanin layer is present in mesocarpic region but discontinuously developed, but except in *Cosmos sulphureus* where phytomelanin layer is continuous in rib region whereas in furrow region, it is discontinuous. Except in *Cosmos sulphureus* in other cypselas vellicular cavity exist. Testal layers are made up of crusted layers of parenchyma cells. Based on the aforesaid morpho-anatomical characters, an artificial key has been presented.

Key words : Cypselar features, Coreopsidae, Asteraceae

INTRODUCTION

Among the 43 tribes of Asteraceae, Coreopsidae consists of 30 genera and 550 species, distributed through out the globe (Kadereit & Jeffrey, 2007). Plants of this tribes are usually annual or perennial herbs, sometimes shrubs, rarely trees. In this tribe, cypselae may be homomorphic or heteromorphic with sometimes resin canals and winged. Pappus structures are represented by either awn like structures or absent. Several species of this tribe are very useful for their horticultural potentiality. According to Panero & Funk (2002) and Funk *et al.*, (2009), molecular data of Heliantheae and related tribes support the recognition of Coreopsidae at the tribal level. On the basis of cypselar morpho-anatomical study, the available literature of this tribe are almost absent, although some species of this tribe previously belonging to the tribe Heliantheae have been studied (Mukherjee & Sarkar, 1998). Now a days Coreopsidae has been recognized as an independent tribe separated from the tribe Heliantheae. The aims of this study is to elaborate the detailed morpho-anatomical structure of cypselas of studied species of this tribe.

MATERIALS AND METHODS

For the present study, dried, identified, mature, cypselas were collected from one foreign herbarium and also from the University of Kalyani Campus and Sikkim, which are given in the table 1.

Table 1

Materials	Sources
1. <i>Bidens cernua</i> L.	Botanischer Garten der Universitat Zurich, XXOZ-19780082. 2008; Drawer
2. <i>Bidens pilosa</i> L.	Gangtok, Sikkim, B. J.-16.
3. <i>Cosmos sulphureus</i> Cav.	University of Kalyani Campus. B. J.-12.

For morphological observation, cypselas were softened by 4% NaOH solution. After that, they were stained in aqueous safranin solution (0.1%) to observe the different morphological parts with the help of simple dissecting microscope (Model No. 363 01, Meopta, PRAHA, Made in Czechoslovakia). For anatomical study, cross sections were done

from the middle part of cypsela with the help of a sharp razor blade to observe the different anatomical region with the help of compound microscope (Metzer).

RESULTS AND DISCUSSION

Bidens cernua

Morphology (Fig. 1 D-H)

Cypsela homomorphic, 9 x 1.5 mm including pappus, 6 x 1.5 mm excluding pappus, black brown, oblanceolate, straight, upper part truncate, whereas lower part tapered. Ellipsoidal in cross sectional configuration. Surface slightly pubescent containing 4-5 ribs, alternating with furrow. Furrows wider than the ribs. At the upper part of cypsela, stylopodium present, prominent, enlarge, partially immersed into the nectary. Pappus represented by 4 unequally arranged, retrosely barbed, pappus bristles yellow brown in colour. At the basal region of cypsela, carpopodium present, narrower than the base of cypsela, symmetric. Carpopodial cells with thick-walled, elongated, arranged in one row.

Anatomy (Fig. 2B)

Cypsela elliptic in cross section. Ribs present; 4-5 in number, conspicuous. Cypselar wall 0.12 mm and 0.11 mm wide at ribs and furrow region respectively. Pericarp thick, differentiated into two zones- epicarp and mesocarp. Epicarp uniseriate, made up of thin-walled, rectangular, compactly arranged parenchyma cells, provided with thick cuticle. Internal to the epicarp, mesocarp present; made up of thin walled, elongated, compactly arranged, parenchyma cells. Thickness of mesocarpic parenchyma cells varies from 2-3 layers in rib region and 4-5 cell layers in furrow region. In each rib there is a small sclerenchyma brace which is constituted by thick-walled, compactly arranged, penta-hexagonal, sclerenchyma cells, containing vascular trace. In between the parenchyma and sclerenchyma cells, near each rib, phytomelanin layer exists which is interrupted in some region. Within the mesocarpic region, just below the rib, vallecular cavity present. Testa attached with cypselar wall, made up of crusted layer of parenchyma cells. Endosperm persists in mature cypsela which is secondarily separated from testa and is made up of uniseriately oriented thick-walled

parenchyma cells. Cotyledons two in number, arranged at right angle to the axis of cypsela, containing 10 resin ducts (5 ducts in each cotyledon).

Bidens pilosa

Morphology (Fig. 1 I-L)

Cypsela heteromorphic. Ray cypsela 10 x 1 mm including pappus, 7 x 1 mm excluding pappus, black-brown, straight, linear. Disk cypsela 8 x 1 mm including pappus, 5 x 1 mm excluding pappus, black-brown, straight, linear. In disk cypsela, surface glabrous whereas in ray cypsela surface slightly pubescent. Surface containing ribs and furrow. Furrows wider than the ribs. Upper part of cypsela, stylopodium present, unenlarged, fully immersed in the nectary. Pappus represented by two, unequally developed, retrosely barbed awns, yellow-brown in colour, 2-3 mm in length. At the basal region of cypsela, carpopodium present, symmetric, ring-like. Carpopodial cells thick-walled, arranged in 2-3 rows.

Anatomy (Fig. 2C)

Cypsela narrow elliptic in cross section. Ribs present; 8-10 in number, inconspicuous. Cypselar wall 0.09 mm and 0.04 mm wide at ribs and furrow region respectively. Pericarp thick, differentiated in to three zones-epicarp, mesocarp and endocarp. Epicarp uniseriate, made up of thin walled, rectangular, compactly arranged, parenchyma cells, provided with cuticle. Internal to the epicarp, phytomelanin layer present; discontinuously arranged. Internal to the epicarp, mesocarp present; homogenous, made up of thick-walled, pentangular, compactly arranged, sclerenchyma cells containing vascular trace. Sclerenchyma cells 2-3 cells wide at the furrow and 9-11 cells wide at the rib region. Internal to the mesocarp, endocarp present, made up of thin-walled, rectangular, uniseriately oriented, compactly arranged, parenchyma cells. Internal to the endocarp, vallecular cavity present. Testa attached with cypselar wall, approximately 0.01 mm thick, made up of crusted layer of parenchyma cells. Endosperm persists in mature cypsela, uniseriate, parenchymatous. Mature embryo occupies a major part of the cypsela. Cotyledons two in number, arranged at right angle to the axis

MORPHO-ANATOMICAL FEATURES OF CYPSELAS IN SOME SPECIES

of cypsela, containing 6 resin ducts (3 ducts in each cotyledon).

Cosmos sulphureus

Morphology (Fig. 1 A-C)

Cypsela homomorphic, 8 x 1 mm, dark brown, linear, slightly curved, tapered at both ends. Quadrangular in cross section. Surface rough and glabrous, margin dentate, containing 4 ribs, alternating with furrow. Furrows wider than ribs. Pappus absent. At the upper part of cypsela, stylopodium present, enlarge, knobe-like, partially immersed in the nectary. At the basal region of cypsela, carpopodium present; symmetric, quadrangular. Carpopodial cells with thick-walled, arranged in one row.

Anatomy (Fig. 2A)

Cypsela quadrangular in cross section. Ribs present; 4 in number, conspicuous. Cypselar wall 0.17 mm and 0.08 mm wide at ribs and furrow

region respectively. Pericarp thick, differentiated in to two zones- epicarp and mesocarp. Epicarp uniseriate, made up of thin-walled, rectangular, compactly arranged, parenchymatous cells, provided with cuticle. Internal to the epicarp, phytomelanin layer present, discontinuously arranged near the furrow region, whereas in ribs region continuously arranged. Mesocarp homogenous, made up of thick-walled, pentangular, compactly arranged, sclerenchyma cells. In furrow region thickness of sclerenchyma cells varies from 3-4 cells, whereas in rib region it is 7-9 cells wide. Testa attached with cypselar wall, approximately 0.01 mm thick, made up of crusted layer of parenchyma cells. Endosperm persists in mature cypsela, made up of thick-walled, uniseriately arranged, parenchyma cells. Mature embryo occupies a major part of the cypsela. Cotyledons 2 in number, arranged oblique to the axis of cypselas, containing 20 resin ducts (10 ducts in each cotyledon).

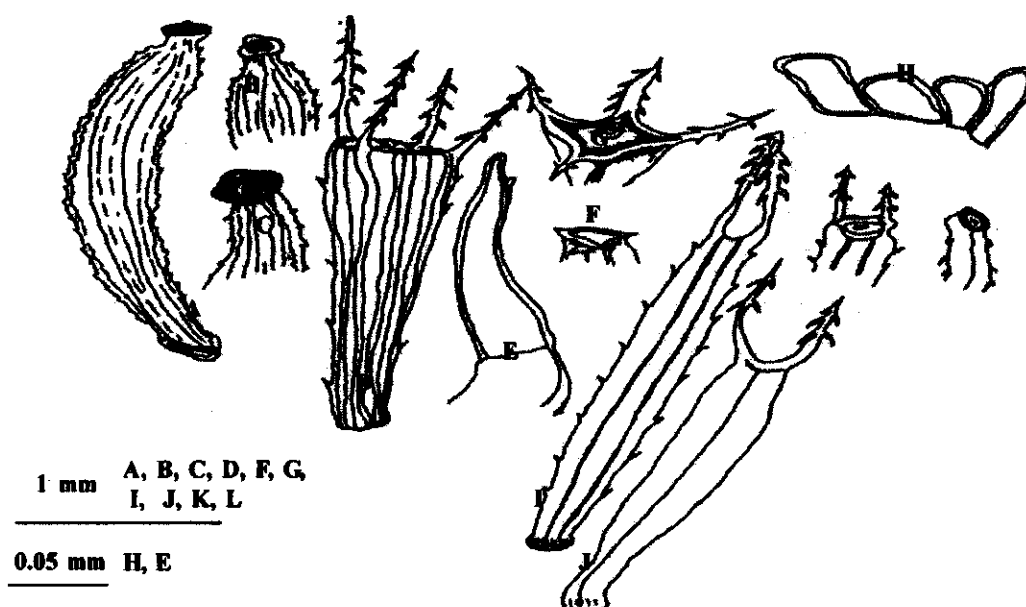
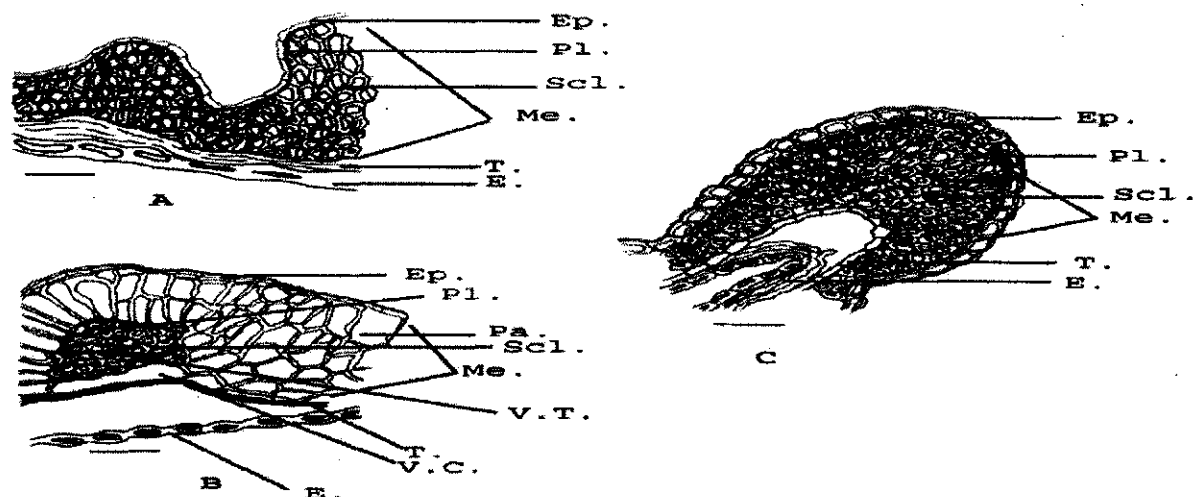


Figure 1. Morphology of studied cypselas

A-C. *Cosmos sulphureus* : A -Cypsela, B- Upper part of cypsela, C- Basal part of cypsela; D-H. *Bidens cernua* : D- Cypsela, E- Surface hair, F- Basal part of cypsela, G- Upper part of cypsela, H- Carpopodial cells; I-L. *Bidens pilosa*: I- Ray cypsela, J- Disk cypsela, K- Upper part of cypsela, L- Lower part of cypsela.



Bar- 0.15mm.

Figure 2. Cross sections of studied cypselas

A- *Cosmos sulphureus*, B- *Bidens cernua*, C- *Bidens pilosa*

Abbreviations: Ep.- Epicarp, Pl.- Phytomelanin layer, Scl.- Sclerenchyma, Me.- Mesocarp, T.- Testa, E.- Endosperm, V.T.- Vascular trace, V.C.- Vallecular cavity, Pa.- Parenchyma

Morpho-anatomical characters of cypselas of three species of the tribe Coreopsidae have been studied to separate them. Among the studied cypselas, largest cypselas is present in the case of *Bidens pilosa* (10 x 1 mm including pappus) whereas the smallest cypselas is present in case of *Cosmos sulphureus* (8 x 1 mm). Shape of studied cypselas varies from linear to oblanceolate. Heteromorphism is seen in the case of cypselas of *Bidens pilosa*, whereas remaining studied cypselas are homomorphic. Homomorphism is also present in another species (*Bidens frondosa*) of this tribe (Jana and Mukherjee, 2012). Colour of cypselas is not an important distinguishing character and is not helpful in the separation of taxa, more clearly. In the case of *Bidens pilosa*, disk cypselas is glabrous whereas ray cypselas is pubescent. In *Bidens cernua*, surface is slightly pubescent. In *Cosmos sulphureus*, surface is rough and glabrous. Among the studied cypselas, in *Cosmos sulphureus*, pappus is absent, whereas in the remaining studied cypselas, pappus are present and which are retrosely barbed type. Mukherjee and Sarkar (2008), have indicated the pappus structures in some tribes of the Asteraceae. There are two opinions on the origin of pappus. These are non-calycine (Small, 1919) or calycine (Lund, 1872) nature of pappus. The universally accepted

view is that the pappus is calycine in nature, i.e., develop from the modified calyx. At the upper part of cypselas, stylopodium is present. It is the modified style base with associated nectaries. In *Cosmos sulphureus* and *Bidens cernua*, stylopodia are prominent and enlarged whereas in other species, stylopodium is unenlarged and is not prominent. Mukherjee (2005) has studied the stylopodial characters of some members of Asteraceae. Carpopodia are basal in position. In all the studied cypselas, carpopodial cells varies from 1-3 rows. Actually carpopodium is the basal, meristematic zone of cypselas (Mukherjee and Nordenstam, 2004) and it helps in the detachment of cypselas from the thalamus. Except the cypselas of *Cosmos sulphureus*, the remaining studied cypselas are elliptical in cross sectional configuration. In all the studied cypselas, phytomelanin layers are present in mesocarpic region. Phytomelanin is found as continuous layer in ribs regions of *Cosmos sulphureus*, but exists as discrete bundle in furrow regions. In *Bidens cernua* and *B. pilosa*, it is found as discrete bundle. Phytomelanin is deposited just inside the epidermis in *Cosmos sulphureus* and *Bidens pilosa*, whereas it is found in deeply situated tissue in *Bidens cernua*. The presence of phytomelanin layer has been indicated in some species (*Helianthus*

MORPHO-ANATOMICAL FEATURES OF CYPSELAS IN SOME SPECIES

annuus, *Xanthium pungens*, etc.) of the tribe Heliantheae (Mukherjee and Sarkar, 1998). Actually phytomelanin is secreted by the glandular activity of hypodermal cells (Pandey, 1989). In *Cosmos sulphureus*, vallecular cavity is absent but present in other studied species. Testa is made up of, crusted layers of parenchyma cells. Resin ducts vary from 3-10 in each cotyledon; 3 in *Bidens pilosa*, 5 in *B. cernua* and 10 in *Cosmos sulphureus*.

CONCLUSION

On the basis of the above characters, it can be concluded that replete the members of the tribe Coreopsideae are with great variations of morphological and anatomical characters of cypselas. These features are admixture of both primitive and advanced features. So the tribe, Coreopsideae can be regarded as heterobathmic in nature.

ARTIFICIAL KEY TO CYPSELA

- 1a. Cypselas heteromorphic; pappus 2, retrose, barbed awns; carpoidal cells 2-3 layers..... *Bidens pilosa*
- 1b. Cypselas homomorphic; pappus absent or represented by 4 retrose barbed awns; carpoidal cells 1 layer..... (2)
- 2a. Pappus present; vellicular cavity present; resin ducts 5 in each cotyledon; phytomelanin layer hypodermal in origin..... *Bidens cernua*
- 2b. Pappus absent; vellicular cavity absent; resin ducts 10 in each cotyledon; phytomelanin layer subepidermal in origin *Cosmos sulphureus*

ACKNOWLEDGEMENTS

We are thankful to Dr. Peter Enz, Curator, Botanischer Garten der Universität Zürich, Zürich, Switzerland, for sending mature, identified seeds, for this study.

REFERENCES

- Funk, V.A., Susanna, A., Stuessy, T. F. and Bayer, R.J. 2009. Systematics, Evolution, and Biogeography of Compositae. International Association for Plant Taxonomy, Vienna, Austria.
- Jana, B. K. and Mukherjee, S. K. 2012. Morphological and anatomical studies of cypselas of 3 species of the family Compositae. IJSD. 2: 386-393.
- Kedereit, J. W. and Jeffrey, C. 2007. Flowering Plants: Eudicots- Asterales. In: The Families and Genera of Vascular Plants (ed). K. Kubitzki, Vol. viii, Springer, Berlin, Germany.
- Lund, S. 1872. Le Calice des Composees. I. (Baegeret hos Kurvblomsterne, histologisk forsog pa at haevde et udviklingens ehed I planteriget). Bot. Tidsskr. Ser. 2: 1-120.
- Mukherjee, S. K. 2005. Comparative studies of stylopodium in some Asteraceae. Plant Taxonomy. Advances and Relevance, Pages 493-503 Eds. A.K. Pandey, Jun Wen & J.V.V. Dogra. CBS Publishers & Distributors, New Delhi.
- Mukherjee, S. K. and Sarker, A. K. 2008. Diversity of pappus structure in some tribes of the Asteraceae. Phytotaxonomy. 8: 32-46.
- Mukherjee, S. K. and Nordenstam, B. 2004. Diversity of carpoidal structure in the Asteraceae and its taxonomic significance. Comp. Newsl. 41: 29-41.
- Mukherjee, S. K. and Sarkar, A. K. 1998. Comparative morpho - anatomical study of cypselas in some species of the tribe Heliantheae (Asteraceae). Bull. Bot. Surv. India 40: 34-46.
- Pandey, A.K. 1989. Phytomelanin-Heliantheae, Asteraceae. Proc. 87th Ind. Sci. Cong. (Sect. Bot.). 111: 244.
- Panero, J. L. and Funk, V. A. 2002. Towards a phylogenetic subfamilial classification for the Compositae (Asteraceae). Proc. Biol. Soc. Wash. 115: 909-922.
- Small, J. 1919. The origin and development of the Compositae. V. The Pappus. New Phytol. 11: 98-123.