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SEED COAT AND PERICARP ANATOMY IN SUBTRIBES MELAMPODIINAE, ZINNIINAE AND ECLIPTINAE (HELIANTHEAE-ASTERACEAE)

ARUN K. PANDEY AND ANUPAMA JHA
Department of Botany, Bhagalpur University, Bhagalpur -812 007
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Achene anatomical studies in subtribes Melampodiinae, Zinniinae and Ecliptinae showed a basic pattern of seed coat and pericarp differentiation. Subtribe Melampodiinae is characterised by the presence of a single-layered epidermis, a 2 layered hypodermis, and fibre bundles followed by inner parenchyma. Cell of the seed coat show fibrous thickenings. *Polymnia* of subtribe Melamopodiinae, however, differs from other genera in the presence of 2-4 layered hypodermis, continuous fibre zone and absence of fibrous thickening in the seed coat cells. Members of subtribes Zinniinae and Ecliptinae show strong similarity in pericarp and seed coat differentiation. The two subtribes differ from each other in the presence or absence of fibrous thickenings in the seed coat cells. In Zinniinae thickening is absent while in Ecliptinae it is present.

Key Words : Ecliptinae, Melampodiinae, Zinniinae, Seed coat, pericarp.

Tribe Heliantheae is one of the largest and morphologically most diverse tribe of the Compositae. Heliantheae has received considerable attention of embryologists but structrual anatomy of seed coat and pericarp has been studied only in limited taxa (Pandey, 1976; Maheswari Devi & Ranjalkar, 1980; Saenz, 1981; Pandey & Singh 1982; Pandey *et al.*, 1986; Pandey and Kumari, 1987; Pandey & Jha, 1992). subtribal grouping of taxa within Heliantheae has received attention of several systematists. Stuessy (1977) recognised 15 subtribes, but Robinson (1981) transferred a number of taxa recognised by stuessy to different subtribes and also created monogeneric subtribes. This resulted in recognition of 35 subtribes. Robinson's classification of Heliantheae is mainly based on achene morphological characters. To ascertain the systematic position of various taxa within subtribes Melampodiinae, Zinniinae and Ecliptinae the present work has been undertaken on 11 genera belonging to these three subtribes.

MATERIALS AND METHODS

Meterials for the present study were obtained from the Seed Herbarium of the National Botanical Research Institute, Lucknow and the Herbarium of the Ohio State University, Columbus.

Mature achenes were kept in 70% ethanol for a week. Customary methods of dehydration in Tertiary-Butyl-alcohol series and embedding in paraffin wax were followed. Microtome sections cut between 12-20 μm thickness were stained in safranin- fast green combination. Mature seed-coat were dissected out from the achenes and were studied for thickening pattern.

OBSERVATIONS

MELAMPODIINAE

Pericarp : Anatomically, the mature paricarps of *Acanthospermum hispidum, Melampodium americanum. M. bibracteatum, M. cupulatum, M. divaricultum, M. glabrum, M. longifolium, M. longipes, M. leucanthum, M. nutans, M. perfoliatum, Polymnia canadensis* and *Sigesbeckia jorullensis* are distinguishable into five distinct zones: epidermis, hypodermis, phytomelanin layer, fibre zone and parenchymatous zone. The epidermis is single- layered and composed of thin-walled parenchymatous cells. The epidermis is followed by a hypodermis which is two-layered in *Acanthospermum, Melamampodium* and *sigesbeckia,* but becomes 2-4 layers thick in *Polymnia* (Fig. 1A B, C). In all genera the hypodermis is composed of large slightly radially elongated cells. The hypodermis is followed by a phytomelanin layer. In *Achanthospermum, Melampodium* and *Sigesbeckia* the phytomelanin layer in discontinuous due to presence of parenchymatous ray like, uniseriately arranged cells, but in *Polymnia* the phytomelanin layer is continuous. Below the phytomelanin layer a fibre zone is present which is composed of thick walled fibres. The fibre zone is continuous in *Polymnia* (Fig 1B) but is discontinuous in *Acanthospermum* (Fig. 1A), *Melampodium* and *Sigesbeckia* (Fig. 1C) forming fibre bundles. These bundles are separated from one another by bands of parenchymatous ray-like

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Table 1: Comparison of pericarp and seed coat anatomy

Taxon	Pericarp				Seed coat	
	Hypodermis (no. of layers)	Phytomelanin layer	Fibre zone	Parenchymatous layer	No. of layers	Thickening (+/-)
Acanthospermum	2	discont.	discont.	4-8	2-4	+
Melampodium	2	discont.	discont.	2-4	2-4	+
Polymnia	2-4	cont.	cont.	2-4	2-4	-
Sigesbeckia	2	discont.	discont.	4-8	2-4	+
Heliopsis	4-6	cont.	cont.	-	1	-
Zinnia	1	cont.	cont.	-	1	-
Aspilia	multi	cont.	cont.	-	1	+
Blainvellia	4-6	cont.	cont.	-	1	+
Eclipta	multi	cont.	cont.	-	1	+
Melanthera	multi	cont.	cont.	1-2	1	+
Wedelia	multi	cont.	cont.	-	1	+

(discont: discontinuous, cont.: continuous,-: absent, +: present)

cells which connect hypodermal cells towards outer and inner parenchymatous zone towards inner side. The innermost zone is composed of 2-8 layers of parenchymatous cells (Table 1).

Seed coat :

The mature seed coat is represented by 2-4 layers of cells. The epidermis of the seed coat is the most prominent layer. In surface view,the cells of the seed coat show fibrous thickening in *Acanthospermum, Melampodium* and *Sigesbeckia* (Fig 2A). Thickenings are, however, absent in the seed coat cells of *Polymnia* (Fig. 2B).

ZINNIINAE

Pericarp : The mature pericarps of *Heliopsis scabra* and *Zinnia peruviana* are distinguishable into four distinct zones: epidermis, hypodermis, phytomelanin layer and fibre zone (Fig. 1D). The epidermis is single-layered and composed of small parenchymatous cells. The underlying hypodermis is single-layered in *Zinnia,* but is 4-6 layers thick in *Heliopsis* (Fig. 1D). The hypodermis is followed by a continuous phytomelanin layer which is undrerlain by continuous fibre zone composed of 2-3 layers of thick-walled cells.

Seed coat : The mature seed coat is composed of 2-3 layers of thin-walled cells. The cells of the seed coat in the two genera studied do not show any type of thickening (Fig. 1D).

ECLIPTINAE

Pericarp : The pericarp anatomy of four genera viz., *Aspilia silphioides, Blainvellia biaristata, Eclipta prostata* and *Wedelia glauca* show similar pattern of pericarp differentiation. The mature pericarp is distinguishable into four zones : epidermis, hypodermis, phytomelanin layer and fibre zone (Fig. 1E, G). In *Melanthera latifolia,* however, parenchymatous zone, present below the fibre zone, was also observed (Fig. 1F). The epidermis is single layered and is composed of parenchymatous cells. The number of hypodermal layers varies in different taxa. It is 4-6 cell-layers thick in *Blainvellia* (Fig. 1G) but it becomes more than 10 cell layers thick in other genera (Table 1). The hypodermis is followed by continuous phytomelanin layer which is underlain by continuous fibre zone. This zone is composed of 4-6 layers of thick-walled cells (Fig. 1 E, F, G).

Seed coat : The seed coat is composed of 1-2 layers of cells. The mature seed coat of all the genera studied show fibrous thickenings (Fig. 1E, F).

DISCUSSION

The pericarp anatomy of the four genera of Melampodiinae is basically similar with five distinct zones observable : epidermis, hypodermis, phytomelanin layer, fibre zone and parenchymatous zone. The epidermis is single layered in all the species, but the number of hypodermal layers varies. It is 2-layered in *Acanthospermum, Melampodium* and *Sigesbeckia* but becomes 2-4 layered in *Polymnia.* The fibre zone is in the form of fibre bundles in *Acanthospermum, Melampodium* and *sigesbeckia* but is continuous in *Polymnia.*

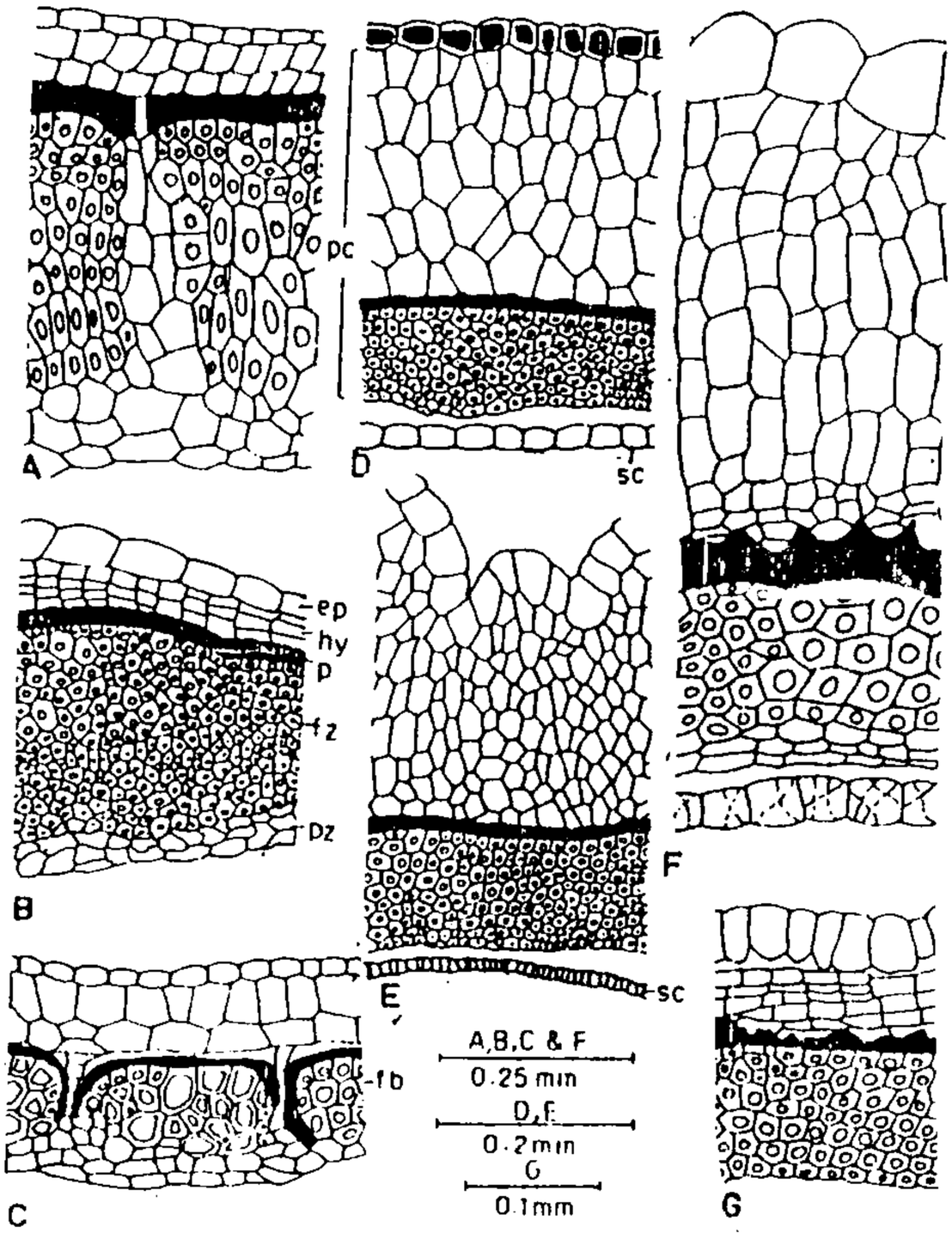

Figure 1. A-G, Achene anatomy. A. *Acanthospermum hispidum.* B. *Polymnia canadensis.* C. *Sigesbeckia jorullensis.* D. *Heliopsis scabra.* E. *Wedelia glauca* F *Melanthera latifolia* G. *Blainvellia biaristata*

ep-epidermis, fb-fibre bunble, fz-fibre zone, hy-hypodermis, p-phytomelanin layer, pc-pericarp, pz-parencymatous zone, sc-seed coat.

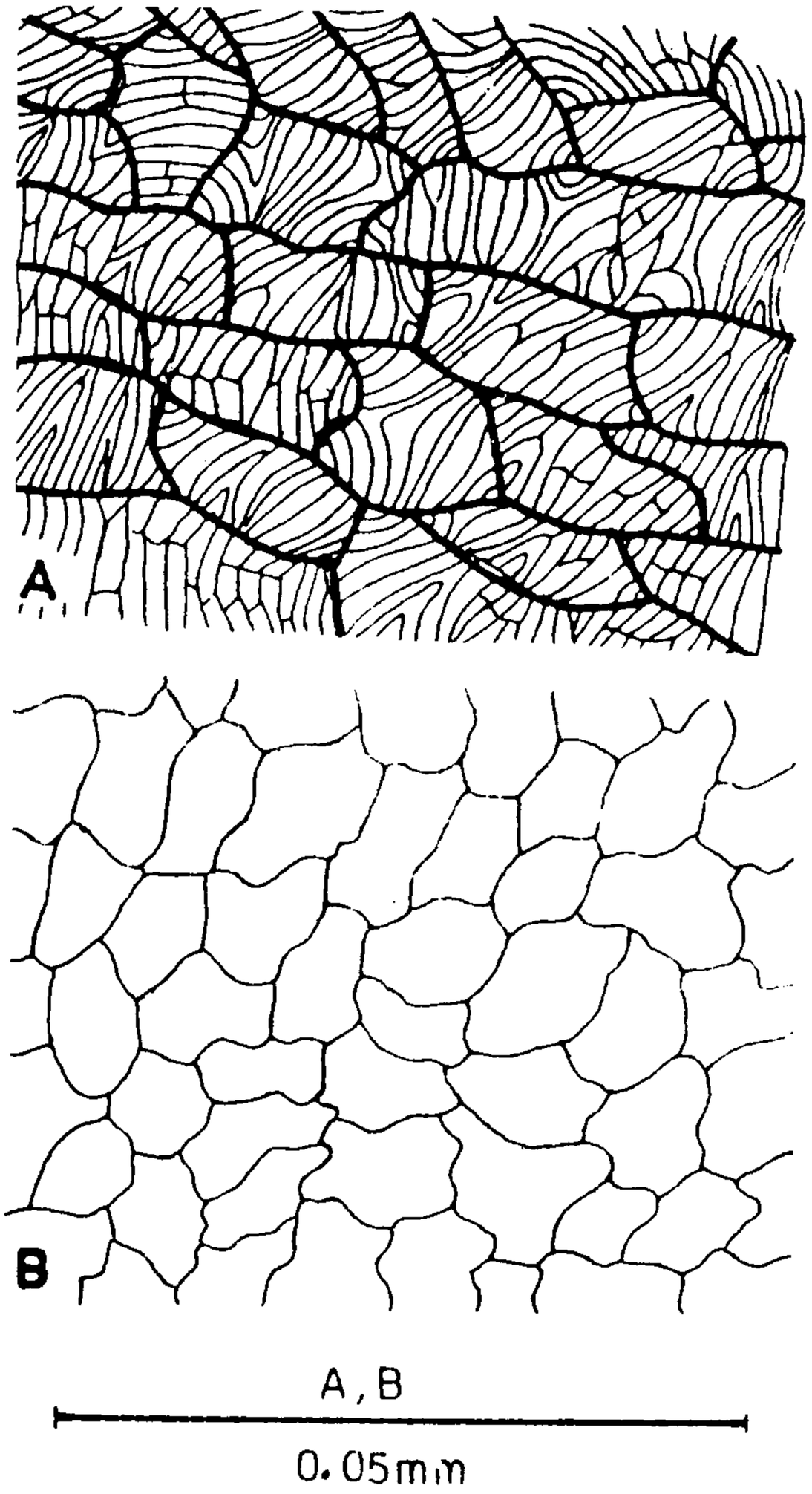

Figure 2 A-B. Seed coat in surface view. A. *Sigesbeckia jorullensis.* B. *Polymnia canadensis.*

The substribe Melampodiinae is characterised by 2-4 cell layers thick seed coat. The cells of the seed coat show fibrous thickenings in *Acanthospermum, Melampodium* and *Sigesbeckia, Polymnia,* however, differs from the above three genera in absence of thickening in the cells of seed coat.

Subtribes Zinniinae and Ecliptinae share a similar pericarp anatomy. The hypodermis is single-layered in *Zinnia,* 4-6 layered in *Heliopsis* and *Blainvellia* and multilayered in *Aspilia, Eclipta, Melanthera* and *Wedelia.* Taxa of both Zinniinae and Ecliptinae show a continuous fibre zone. In this feature Zinniinae and Ecliptinae differ from Melampodiinae (except *Polymnia*) where the fibre zone is in the from of fibre bundles.

The mature seed coat in members of the Zinniinae and Ecliptinae is usually single- layered, but these subtribes differ in the presence or adsence of fibrous thickenings on the seed coat cells. All the genera of Ecliptinae show fibrous thickenings in the epidermal cells of the seed coat but members of Zinniinae do not show such thickenings.

Although *Polymnia* shares a similar basic pattern of seed coat and pericarp differentiation with other members of Melampodiinae it, however, differs from them in characters like: (i) 2-4 layered hypodermis, (ii) continuous phytomelanin layer, (iii) continuous fibre zone and (iv) seed coat cells devoid of any type of thickening. Stuessy (1977) placed *Polymnia* in the

subtribe Melampodiinae. Robinson (1981) trasferred *Polymnia* from Melampodiinae to a new subtribe polymniinae. The morphological characters of *Polymnia* resemble to a great extent with other members of Melampodiinae therefore, we support Stuessy's placement of this genus in subtribe Melampodiinae.

Robinson (1981) transferred *Sigesbeckia* from Melampodiinae to subtribe Milleriinae. Our observations on the achene anatomy of the genus suggest that *Sigesbeckia* shows close similarity with other members of Melampodiinae viz., *Acanthospermum* and *Melampodium* in sharing features such as : a single-layered epidermis, a 2-layered hypodermis, discontinuous phytomelanin layer, fibre zone in the form of fibre bundles, the presence of parenchymatous zone and seed coat cells having fibrous thickenings.

Robinson (1981) dismantled subtribe Zinniinae and transferred all the genera to subtribe Ecliptinae. Although taxa of both the subtribes show similar patterns of pericarp and seed coat differentiation, they differ in the presence or absence of fibrous thickenings in the seed coat cells. In *Heliopsis* and *Zinnia* (subtribe Zinniinae) fibrous thickenings are completely absent, while the seed coat cells of the members of Ecliptinae (*Aspilia, Blainvellia, Eclipta, Melanthera* and *Wedelia*) show fibrous thickenings. Based on achene anatomical features subtribes Zinniinae and Ecliptinae are more closely related.

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