STRUCTURE AND DEVELOPMENT OF SEEDS OF *WRIGHTIA* SPECIES (APOCYNACEAE)

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Abstract

Structure and development of seeds in three species of *Wrightia* are described. The ovary is bilocular; in *Wrightia coccinea* and *W. tomentosa* it is syncarpous, while apocarpous condition is found in *W. tinctoria*. Ovules are hemianatropous, unitegmic and tenuinucellate. Cotyledons are folded in convolute fashion within the seed. Cells of the outer epidermis of integument form the important layer of seed coat. Seed hairs show annular thickening at their bases. Spermodermal pattern, as seen under SEM, is polygonal and reticulate.

Introduction

Embryological literature in the family Apocynaceae has been reviewed by Davis (1966), Maheswari Devi (1970, 1971) and Maheswari Devi and Lakshminarayana (1975), and work on seed anatomy has been summarised by Netolitzky (1926) and Corner (1976). Khan (1970) and Lattoo (1974) also studied seed structure in some of the taxa of this family. However, the existing literature reveals that detailed work on seed structure especially the development of the seed coat is fragmentary and needs investigation. The present communication describes these aspects in three *Wrightia* species.

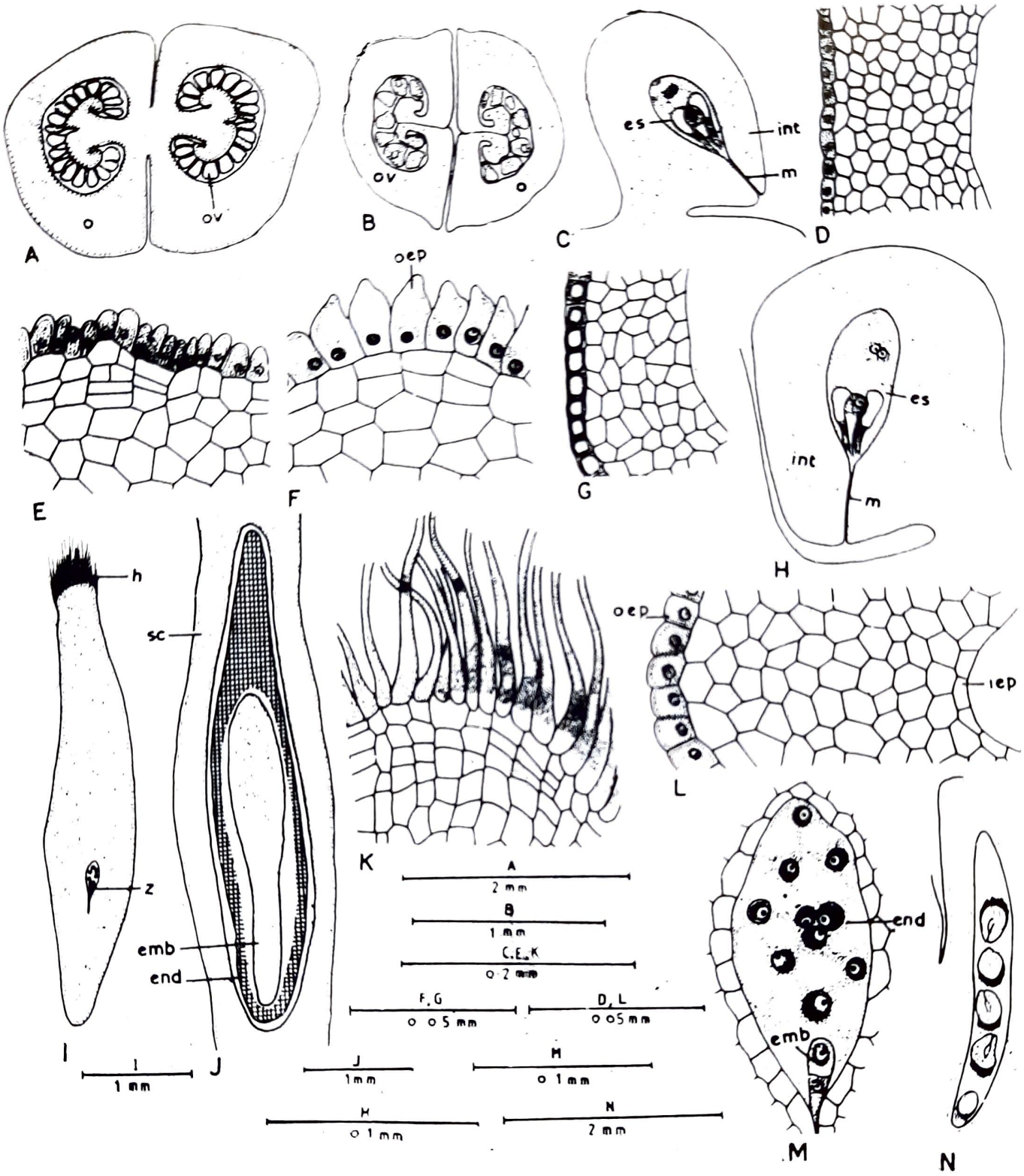
Materials and methods

Flowers and fruits at different stages of growth of *Wrightia coccinea* Sim. *W. tinctoria* R. Br. and *W. tomentosa* R. & S. collected locally, were fixed in formalin-acetic-alcohol and later stored in 70 per cent ethanol. Mature fruits were bagged with well perforated polyethylene bags to collect the dehisced seeds without loss of hairs.

The materials were dehydrated through tertiary butyl alcohol series and embedded in paraffin wax in the usual way. Serial microtome sections, 8 to 16 μm thick, were stained with safranin and fast-green combination. Maceration of the seed coat was done according to Jeffery's method (Johanssen, 1940). For localization of tannin in the seeds at various stages of growth, methods of Reeve (1951, 1959) were employed. Mature seeds were also hand-sectioned to test the presence of lipid according to Gomori's method (see Jensen, 1962). Spermodermal pattern of seeds as well as basal region of hair were studied using Scanning Electron Microscope (Jeol JSM-35C model operated at 10 kv) after necessary technical processing.

Observations

Ovary and ovule—The gynoecium is bicarpellary in all the three species. Ovaries are syncarpous, bilocular and superior in *W. coccinea* and *W. tomentosa* (Text-fig. 1A), whereas in *W. tinctoria* the condition is apocarpous (Text-fig. 1B). The ovules are hemianatropous, unitegmic and tenuinucellate and are attached to the swollen placenta (Text-fig. 1C, H). The micropyle is long and quite narrow.



Text-fig. 1 A-N—*Wrightia coccinea* : A,T.S. of ovary; C,L.S. of ovule at female gametophyte stage; D,L.S. of integument at the level of female gametophyte; E-epidermal cells at the chalazal end at the time of fertilization; J-L.S. of young seed; L-L.S. of part of integument at early pro-embryo stage.

Wrightia tinctoria : B-T.S. of ovary; G-L.S. of part of integument at organised female gametophyte stage at embryo sac level; I-L.S. of developing seed at zygote stage; M-L.S. of part of ovule at 2-celled pro-embryo stage.

Wrightia tomentosa : F-L.S. of part of integument at chalazal end at zygote stage; H-L.S. of ovule at organised female gametophyte stage; K-L.S. part of integument at chalazal end at 2-celled embryo stages; N-L.S. of young fruit. Note the terminal ovule in reverse orientation. (emb, embryo; end, endosperm; es, embryo sac; h, hair; iep, inner epidermis of integument; int, integument; m, micropyle; o, ovary; oep, outer epidermis; ov, ovule; sc, seed coat; z, zygote).

The organised female gametophyte consists of an egg apparatus, two polar nuclei and three antipodal cells. The two synergids and the egg are quite large and reach half the length of the embryo sac in *W. coccinea* and *W. tinctoria* (Text-fig. 1C), whereas in *W. tomentosa* the egg apparatus though large does not reach the same distance (Text-fig. 1 H). The three antipodal cells are ephemeral. At this stage, the number of cell layers in the integument ranges from 8 to 10 in *W. coccinea* and 5 to 7 in *W. tinctoria* and *W. tomentosa* on the antiraphe side at the level of the female gametophyte (Text-fig. 1D, G); elsewhere the number fluctuates. The innermost layer does not differentiate into an endothelium in any of the species.

Edosperm and embryo—The primary endosperm nucleus divides earlier than the zygote and the endosperm development is nuclear (Text-fig. 1M). The free nuclear endosperm finally becomes cellular and wall formation occurs centripetally. The endosperm envelopes the developing embryo (Text-fig. 1J) and in a fully developed seed about three or four cell-layers of endosperm persist on the lateral side of the embryo, whereas the number of cell-layers is more on the radicular and cotyledonary ends. The endosperm contains reserve food material, lipid being one of the major constituents.

The mature embryo is differentiated into a hypocotyl root-axis, two cotyledons and a shoot-tip. The cotyledons are much longer than the hypocotyl-root-axis and are leafy. They are folded in convolute fashion (Text-fig. 2C, E, I). The vascular supply in the embryo is procambial and is branched in the cotyledons. The cells of the embryo contain reserve food material of the type seen in the endosperm. Many of them contain druses of calcium oxalate (Text-fig. 2N). Laticifers are also present in the embryo.

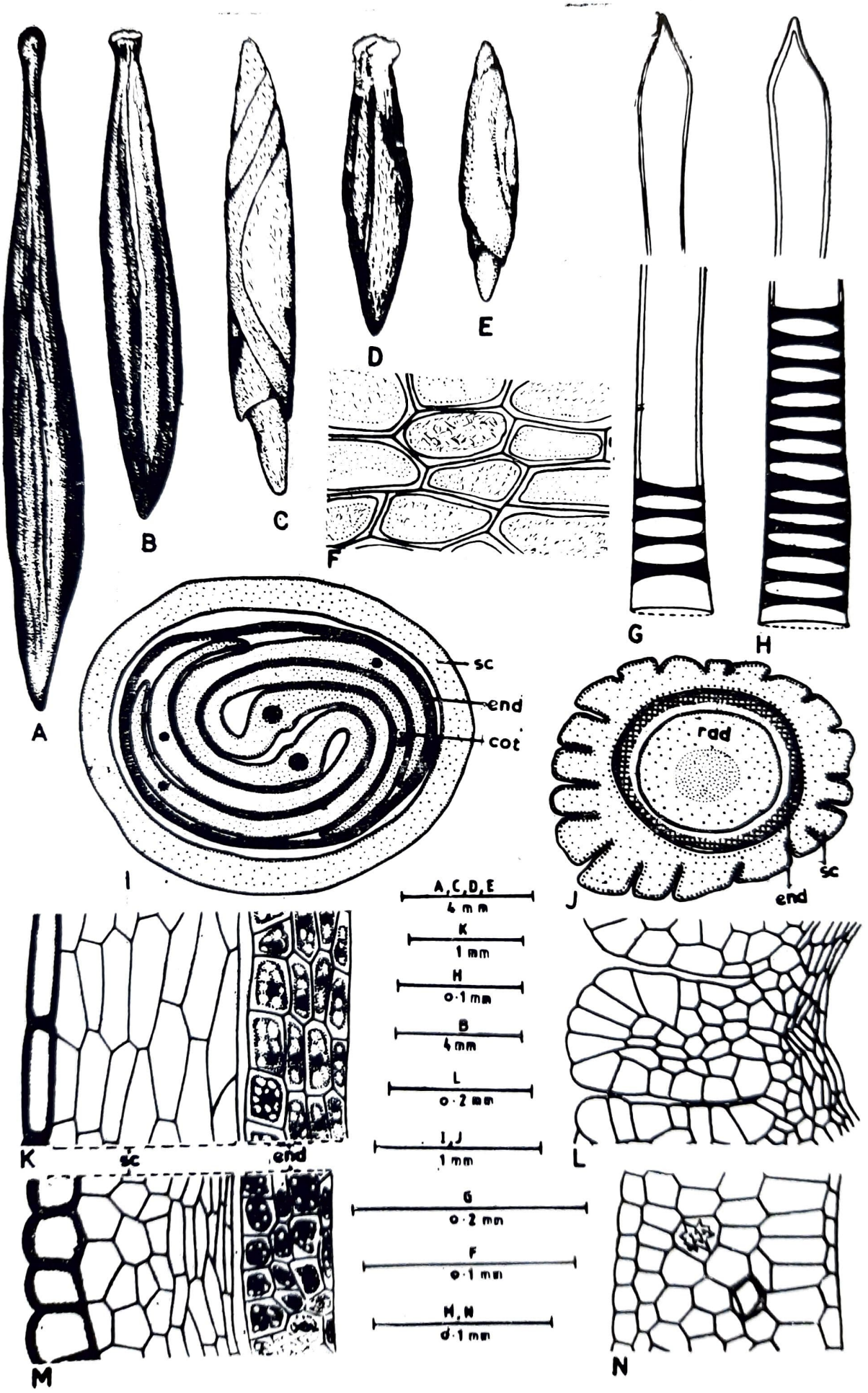
Seed coat—Soon after fertilization, the ovule grows. In the region of the chalaza, even at the zygote stage, most of the epidermal cells destined to form hairs which become papillose (Text-fig. 1E, F).

The cells below the epidermal layer towards the micropylar and chalazal sides divide actively (Text-fig. 1E, F, K) and make the growing seed elongate considerably; the growth in the chalazal region is, however, much more (Text-fig. 1I). In one ovary a few ovules are inversely oriented in the locule in *W. tomentosa* (Text-fig. 1N). Cell divisions also occur on the lateral sides of the ovule resulting in more cell-layers (Text-fig. 1L). As the seed develops further, the growing embryo consumes most of the cells and in a mature seed, the seed coat remains only a few cell layers thick. The cells of the outer epidermis get thickened and contain tanniniferous deposition (Text-fig. 2K, M), whereas rest of the cells remain thin-walled. At the micropylar and chalazal sides the seeds show grooved structures which are formed owing to differential growth of the seed coat (Text-fig. 2J, L). In a fully mature dry seed, the epidermal cells form the most distinct layer of seed coat. These cells in surface view are polygonal in outline (Text-fig. 2F).

The spermodermal pattern under SEM also shows the polygonal pattern in the three species (Pl. 1, figs. 1-4). The thickening pattern is, however, somewhat different in the three species. The thickening of the epidermal cells in the region of grooves is more than in other regions of seed (compare Pl. 1, figs. 2, 3).

Mature seed—The fruits in all the three species are follicle. The length of the follicle under Lucknow conditions ranges between 30-35, 35-40 and 15-20 cm in *W. coccinea*, *W. tinctoria* and *W. tomentosa* respectively. In *W. coccinea* and *W. tomentosa* the two follicles are connate throughout, whereas in *W. tinctoria* only the tips of the follicles are adhering. Number of seeds per follicle varies from 22-69, 26-35 and 11-15 in *W. coccinea*, *W. tinctoria* and *W. tomentosa* respectively.

The seeds are endospermic. They are light brown in colour and nearly ellipsoidal in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Text-fig. 2

shape (Text-fig. 2A, B, D). In general, the chalazal side is much drawn out than the micropylar in *W. coccinea* as compared to other two species. At the chalazal end the seeds are slightly knob-shaped and bear a tuft of white silky unicellular hairs which are epidermal in origin. The hairs are easily detachable. The main body of the seeds is about 10 to 20 mm long in *W. coccinea*, 18 to 21 mm in *W. tinctoria*, and 13 to 15 mm in *W. tomentosa*. On the ventral side of the seed an elongated scar of hilum is evident. In all the three species the seed-surface is rough and grooved outline is present near the micropylar end. The hairs are about three times longer than the main body of seed. In all the three species they show lignified annular thickenings in their basal parts (Text-figs. 2G, H; Pl. 1, figs. 5, 6). The number of annular thickenings are more in *W. tinctoria* as compared to the other two species. The apical end of the hair is slightly swollen and ends in a pointed tip.

Discussion

The ovules studied in three species of *Wrightia* are unitegmic, tenuinucellate and hemianatropous as recorded for many other taxa of Apocynaceae (Davis, 1966; Khan, 1970; Bhasin, 1971; Maheswari Devi, 1970, 1971, 1974; Lattoo, 1974; Maheswari Devi & Lakshminarayana, 1975). Hemianatropous to anatropous ovules are observed in *Hunteria zeylanica* (Maheswari Devi & Lakshminarayana, 1977).

Integumentary tapetum is not differentiated in any of the three species of *Wrightia* studied. Absence of endothelium is also reported in *Carissa carandus*, *Cerbera odollam*, *Funtumia elastica*, *Ichnocarpus frutescens*, *Vallaris heyneii* and *Wrightia tinctoria* (Rau, 1940).

Of interest is the presence of much enlarged egg and the synergids in the three *Wrightia* species. Enlarged condition of the synergids is also reported in many apocynaceous taxa studied (Rau, 1940). Enlarged condition of the egg apparatus has probably some thing to do with the nutritional aspect of these three cells.

The endosperm development is nuclear and finally the endosperm becomes cellular and envelopes the developing embryo in all the three species. Foldings of cotyledons in a characteristic covolute manner found within the seed of all the three species of *Wrightia* appears to be characteristic feature of the genus *Wrightia*.

Active growth of the integument on the micropylar side and of the integument and chalaza on the chalazal side of the ovule is responsible for the elongation of developing seeds in these two directions. The mature seed coat in *Wrightia* species is only a few cell layers thick and the cells of the outer epidermis are thickened and contain tanniniferous deposition. They form the most characteristic layer. The rest of the cells of the seed coat are thin-walled. Many layered seed coat is reported in *Rauvolfia tetraphylla*, *Voacanga foetida* (Maheswari Devi, 1971), *Holarrhena antidysenterica* (Lattoo, 1974) and *Beaumontia grandiflora* (Sud, 1985). Maheswari Devi (1974) also found that seed coat in *Carissa spinarum* consists of conspicuous epidermal cells and 2-3 layers of degenerating cells. On the other hand, the seed coat consists of only one layer represented by the outer epidermis in *Hunteria zeylanica*

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Text-fig. 2 A-N—*Wrightia coccinea:* A-ventral view of mature seed; C-Mature embryo with folded leafy cotyledons; G-Hair base and tip of hair magified; I-T.S. of mature seed with covolute foldings of cotyledons; K-L.s part of seed coat and endosperm at mature seed stage.

Wrightia tinctoria: B-ventral view of the seed; H-Hair base and tip of hair magnified; J-T.S. of seed passing through radicular part of embryo; L-T.S. part of integument showing grooves near micropylar end; M-L.S. part of seed coat and endosperm at mature seed stage; N-L.S. of part of cotyledon showing diuses of calcium oxalate.

Wrightia tomentosa : D-ventral view of mature seed; E-mature embryo with folded cotyledons; F-surface view of the epidermal cells of seed coat. (cot, cotyledons; end, endosperm; rad, radicle; sc, seed coat).

(Maheswari Devi & Lakshminarayana, 1977), *Catharanthus roseus* (Maheswari Devi, 1971), and *C. pusillus* (Khan, 1970; Maheswari Devi, 1971).

The fruits in the three *Wrightia* species are follicle. In *Wrightia coccinea* and *Wrightia tomentosa* the two follicles are connate throughout, whereas in *Wrightia tinctoria* only the tips of the follicles are adhering. At the chalazal end the seeds are slightly knob-shaped and bear a tuft of white silky unicellular hairs. These hairs are easily detachable and help in the dispersal of seeds. Formation of hairs is not a constant feature in all the taxa. Presence of annular thickenings at hair bases seems to be a characteristic feature in *Wrightia* species and probably these thickenings provide mechanical strength to the hair. Pijl (1969) has laid emphasis on the role of hairs in seed dispersal in Apocynaceae and Asclepiadaceae. Spermodermal pattern is reticulate with interwoven rugae in the central part of cells.

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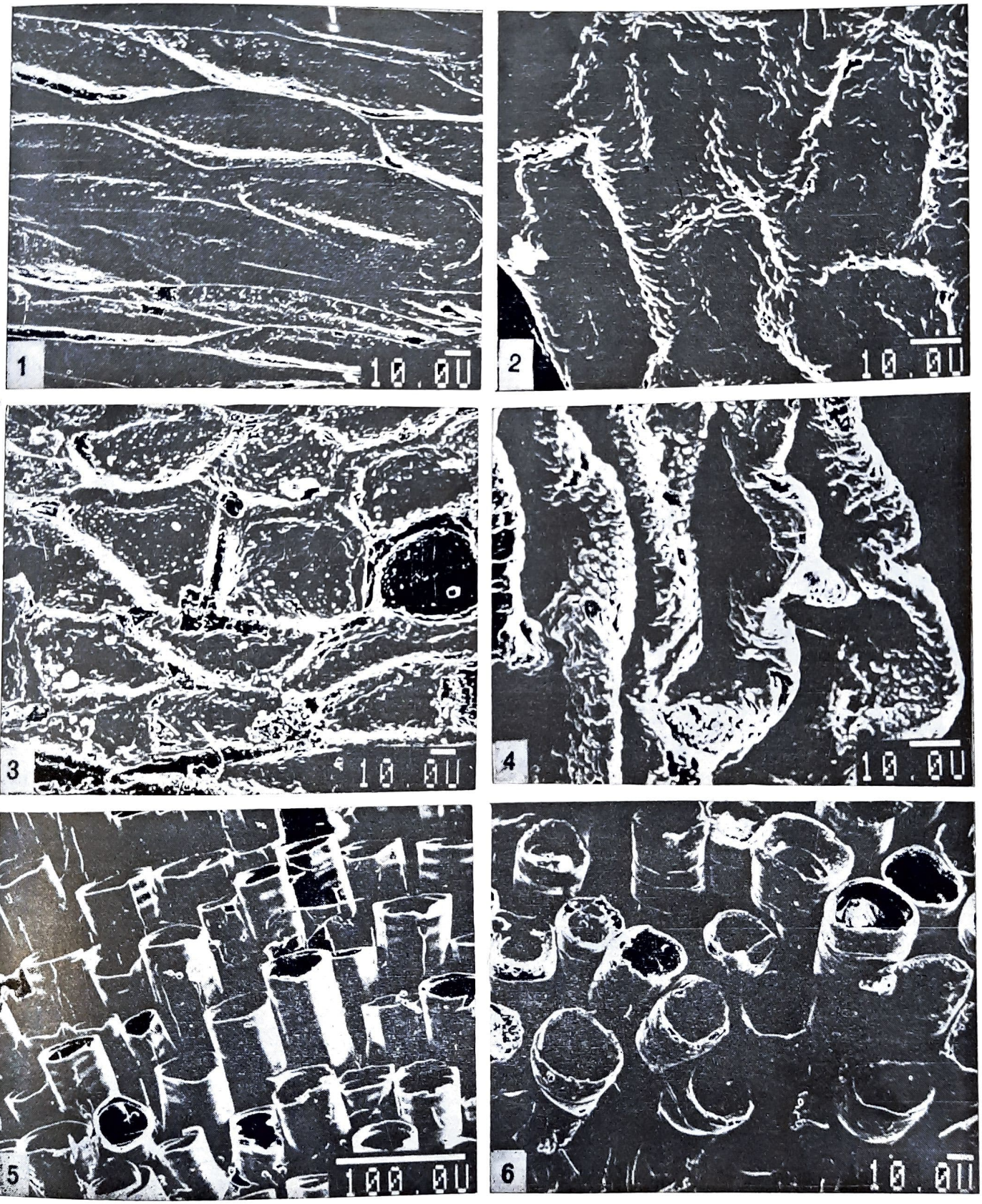
Explanation of Plate

1-3. Epidermal cells of seed coat under SEM in *Wrightia coccinea*, *W. tinctoria* and *W. tomentosa*, respectively.

4. Epidermis in region of groove of *Wrightia tinctoria*.

5 & 6. Basal region of the hair showing annular thickenings in *Wrightia tinctoria* and *W. coccinea*, respectively.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