

SEED STRUCTURE IN RELATION TO THE TAXONOMY OF THE HIBISCEAE (*HIBISCUS* AND *LAGUNARIA*)

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Abstract

The internal and external features of the seeds of 23 species of the Hibisceae (Malvaceae) have been studied with the help of the light and scanning electron microscopes. Seed structure and its relation to the tribal division of the family is discussed.

Introduction

The seed structure is related with different characters of the flower and fruit of the family Malvaceae which consists of a natural group of plants with slight variation among its members. Seeds may develop from anatropous (Khushk & Vaughan, 1985) or campylotropous ovules. Hairs may or may not be present on the testa epidermis. When present, they show interesting variations in structure. The cells of the testa epidermis may be thick-walled or thin-walled. Within the epidermis, the parenchyma zone shows variation in the number of cell layers. This zone may be limited internally by a clear layer of cells, sometimes with calcium oxalate crystals. The layers develop from the outer integument of the ovule. The outer epidermis of the inner integument forms the highly characteristic palisade or malpighian cells which show variation according to the taxon. In the testa, which consists essentially of parenchyma layers, variation is related to the number of these layers. A layer of cells with curiously pitted walls, the 'fringe layer', forms the innermost layer of the testa. The gossypol cavities are absent in embryo whereas these have been found in *Gossypium*, *Lberonnecia* and *Thespesia* (Khushk & Vaughan, 1985).

The literature on published work on seed anatomy of Hibisceae includes: *Abelmoschus esculentus* (L.) Mey. (Syn. *Hibiscus esculentus* L.): Kondo, 1925; Reeves, 1936b; Chandra & Bhatnagar, 1975. *A. manihot* Medic. (Syn. *Hibiscus manihot* L.): Kondo, 1925. *A. moschatus* Medic.: Singh, 1968; Corner, 1976. *A. spp.*: Netolitzky, 1926; Kundu & Biswas, 1973.

Decaschistia crotonifolia: Dariev, 1975. *D. harmandii*: Dariev, 1975. *D. trilobata*: Dariev, 1975. *Dicellostyles axillaris*: Dariev, 1975. *Hibiscus cannabinus* L.: Kondo, 1925; Vaughan, 1970; Corner, 1976. *H. esculentus* L.: Vaughan, 1970; Corner, 1976. *H. hirtus* L.: Rao, 1955. *H. micranthus* L.: Rao, 1955. *H. sabdariffa* L.: Kondo, 1925. *H. solandra*

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L. Heriit.: Rao, 1955. *H. spp.*: Netolitzky, 1926; Kundu & Biswas, 1973. *H. syriacus*: Guignard, 1893. *H. trionum*: Netolitzky, 1926.

Ingenhousia triloba Moc. & Sesse: Reeves, 1936b. *Julostylis angustifolia*: Dariev, 1975. *Kydia calycina*: Dariev, 1975. *K. glabrescens*: Dariev, 1975. *K. jujubifolia*: Dariev, 1975. *Paritium tiliaceum* Juss.: Reeves, 1936b. *Thespesia danis*: Dariev and Mirzarkhimoova, 1974. *T. populnea* (L.) Soland. ex Correa: Reeves, 1936b; Corner, 1976. *T. populneoides* (Roxb.) Kostel.: Corner, 1976.

The seed structure of 2 genera and 23 species of Hibisceae studied with light microscopy and the scanning electron microscope is described. The structural variation related to the taxonomy of the tribe is discussed.

Material and Methods

Seed samples collected from different sources possessed voucher numbers, whereas others were unauthenticated. The unidentified seeds were grown at the Chelsea Physic Garden. When fully grown, the plants were identified in the Herbarium of the Natural History Museum, London. Herbarium sheets were prepared of all material grown. Representative samples contained five seeds which were selected from each accession of a species. Seed characters were recorded of each species.

Results

The general morphology and the internal structure of the seed of each species have been recorded following the classification by Hutchinson (1967). Little variation in structure is shown by various accessions of each species. Variation is shown in seed length, colour and shape. Three shapes have been recognized:- cuneiform (wedge-shaped); compressed reniform with one end narrowed; pear-shaped. The funicle may be persistent or absent. As regards Hibisceae, the anatomy of testa in genera like *Gossypium*, *Lebronnecia* and *Thespesia* show that the mesophyll of the outer integument (OM) and the inner epidermis of the outer integument (IE) are present whereas OM and IE are seen to be absent in *Hibiscus* and *Lagunaria*. Likewise the cotyledons, *Gossypium*, *Lebronnecia* and *Thespesia*, are much folded but in *Hibiscus* and *Lagunaria* these have been found to be slightly folded. The hairs on the seed surface show variation of distribution and structure. In the *Hibiscus* species recorded, the hairs are described as unicellular and in groups. An alternative interpretation is to regard these units as multicellular hairs.

Anatomically, the different regions of the testa have been divided as under: the outer epidermis (developed from the outer epidermis of the outer integument); the palisade layer (outer epidermis of inner integument); the palisade layer (outer epidermis of inner integument); the fringe layer (inner epidermis of inner integument). The major variation

observed is the absence of the gossypol cavities in the embryo. The seed characters have been described in abbreviations:

GM: General morphology, L: Seed length; C: Colour, BL: Black, BR: Brown, G: Grey, GR: Green, RB: Reddish Brown, OG: Olive Green; S: Shape, CR: Compressed reniform with one end narrowed, CU: Cuneiform, P: Pear-shaped, FA: Funicle absent, FA; Funicle absent, FP: Funicle persistent, CO: Cotyledons, SF: Slightly Folded, H: Hairs. The minimum and maximum length for hairs is given, together with the average (a).

T: Testa, OE: Outer epidermis, developed from outer epidermis of outer integument, PL: Palisade layer, developed from outer epidermis of inner integument, IM: Mesophyll of inner integument, FL: Fringe layer, developed from inner epidermis of inner integument.

Hibiscus abelmoschus L. (Fig. 1). Accession: K/87 GM: L, 5 mm; C, BL and G; S, P; CO, SF. H: not present. T: OE, one or many layers of cells (cells with thickened inner tangential and radial walls); PL, 195 μm , lumen in middle of cell; IM, 1-15 layers; FL, present.

Hibiscus aponeurus Sprague & Hutchins. (Figs. 2, 3, 4, 5). Accession: K/31 GM: L, 2 mm. C, BL and BR; S, CR; FA; CO, SF. H: Bi- and tri-cellular; single and up to 6 in a group; pointed and blunt; 60-1500, a. 780 μm . T: OE, one layer of cells, cells below hairs elongated radially; PL, 85 μm , lumen in middle of cell; IM, 1-5 layers. FL, present.

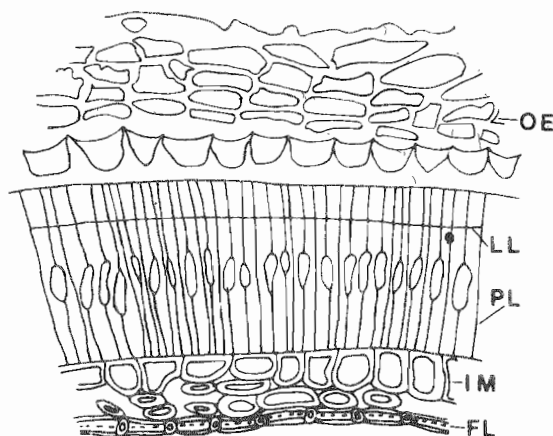


Fig. 1. Transverse section of seed coat of *Hibiscus abelmoschus* L. x 470. FL, Fringe layer, developed from inner epidermis of inner integument; H, Hairs; IM, Mesophyll of inner integument; LL, Light line; OE, Outer epidermis, developed from outer epidermis of outer integument; OM, Mesophyll of outer integument; PL, Palisade layer developed from outer epidermis of inner integument.

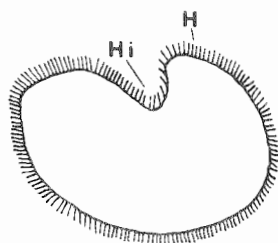


Fig. 2. *Hibiscus aponeurus* Sprague & Hutchins. Side view of hilum, x 30.

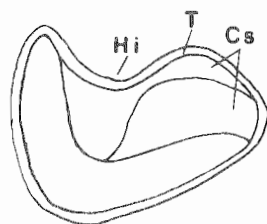


Fig. 3. *Hibiscus aponeurus* Sprague & Hutchins. Section through seed showing foldings of cotyledons, x 30. Cs, Cotyledons; H, Hairs; Hi, Hilum; T, Testa.

Hibiscus calycinus Willd. (Fig. 6). Accession: K/55 GM: L, 3 mm; C, BL and G. S, CU; FP; CO, SF. H: Unicellular, pointed; 195-154 $^{\circ}$, a. 770 μ m; around hilum, very long hairs present, a. 950 μ m. T: OE, two or three layers of cells; PL, 145 μ m, lumen in upper 1/3 of cell; IM, 1-2 layers; FL, present.

Hibiscus cameroni Knowles & Westc. (Fig. 7). Accession: K/32 GM: L, 2.5-3 mm; C, BL; S, CU; FP; CO, SF. H: Uni- and tri-cellular, single and up to 8 in a group; bun-shaped and slightly pointed; 55-90, 70 μ m. T: OE, disorganized; PL, 105 μ m, lumen in upper 1/3 of cell; IM, 1-3 layers; FL, present.

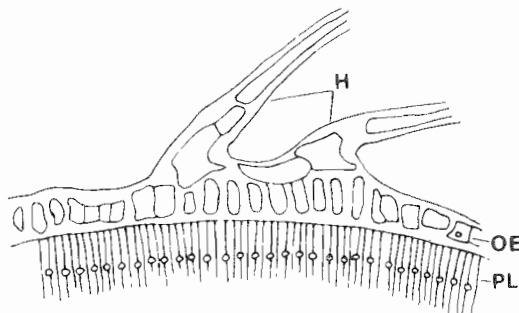


Fig. 4. T.S. of seed coat of *Hibiscus aponeurus* Sprague & Hutchins. Abbreviations as in Fig. 1.

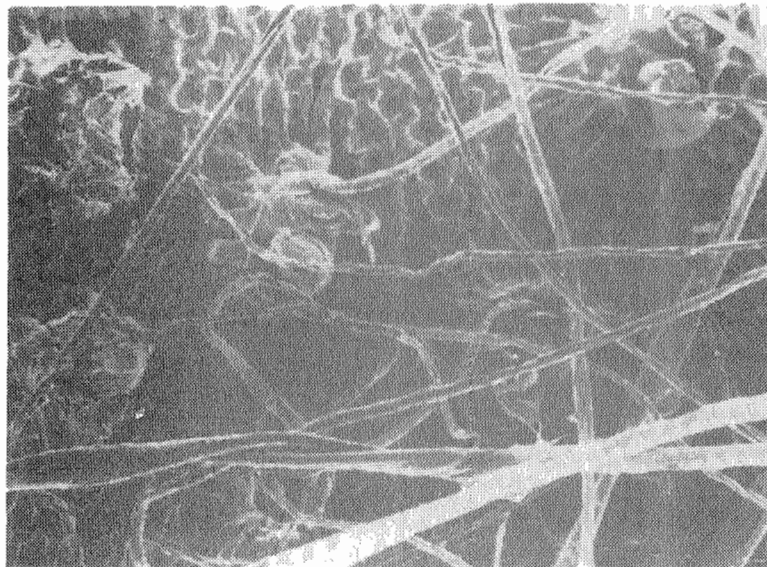


Fig. 5. *Hibiscus aponeurus* Sprague & Hutchins. SEM, Distribution of hairs, x 1000.

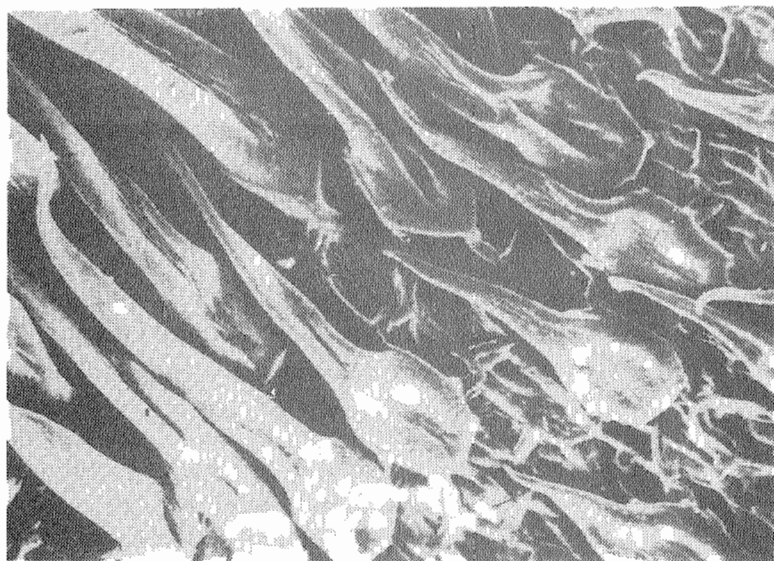


Fig. 6. *Hibiscus calycinus* Willd SEM. Distribution of hairs, x 3000.

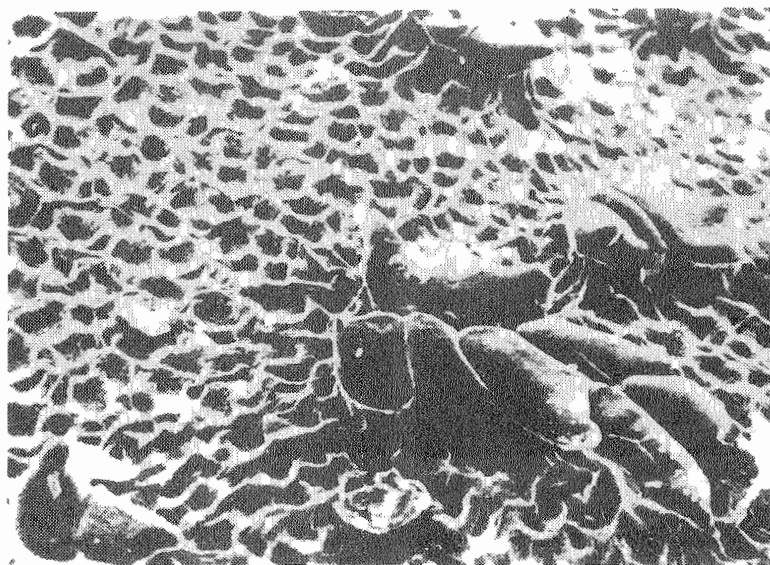


Fig. 7. *Hibiscus cameroni* Knowles & Westc. SEM, Distribution of hairs, x 1000.

Hibiscus cannabinus L. (Fig. 8) Accessions: K/66, K/179 GM: L, 2 mm; C, BL; S, CU; FP; CO, SF. H: Unicellular, single and up to 3 in a group; bun-shaped; 30-70, a. 45 μ m. T: OE, one or two layers of cells; PL, 110 μ m, lumen in upper 1/3 of cell; IM, 1-3 layers; FL, not present.

Hibiscus cardiophyllus A. Gray (Fig. 9) Accession: K/180 GM: L, 3 mm; C, BL and BR; S, CU; FP; CO, SF. H: Unicellular, single and up to 5 in a group; pointed; 170-280, a. 210 μ m; around hilum, very long hairs present, a. 400 μ m. T: OE, one or two layers of cells; PL, 205 μ m, lumen in upper 1/3 of cell, IM, 1-7 layers; FL, present.

Hibiscus coccineus Walt. Accessions: K/173, K/181 GM: L, 3 mm; C, BR; S, CU; FP; CO, SF. H: Unicellular, single and up to 8 in a group; bun-shaped and pointed; 35-75, a. 55 μ m. T: OE, one layer of cells; PL, 115 μ m, lumen in upper 1/3 of cell; IM, 1-7 layers; FL, present.

Hibiscus cubensis A. Rich. Accession: K/182 GM: L, 2.5 mm; C, BR; S, CU; FP; CO, SF. H: Unicellular, single and up to 8 in a group; pointed; 240-390, a. 315 μ m. T: OE, one layer of cells; PL, 135 μ m, lumen in upper 1/3 of cell; IM, 1-8 layers; FL, present.

Hibiscus diversifolius Jaq. Accession: K/56 GM: L, 3 mm; C, BL; S, CU; FP; CO, SF. H: Unicellular, single and up to 4 in a group; pointed; 40-280, a. 140 μ m. T: OE,

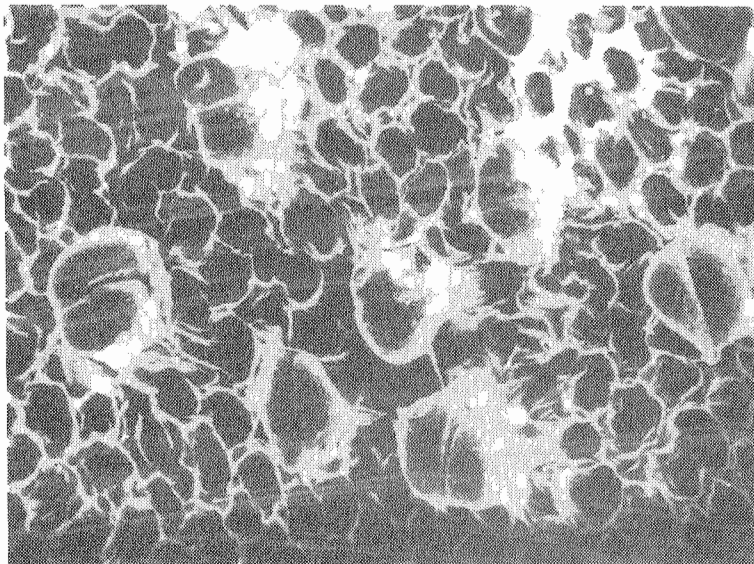


Fig. 8. *Hibiscus cannabinus* L. SEM, Distribution of hairs, x 1000.

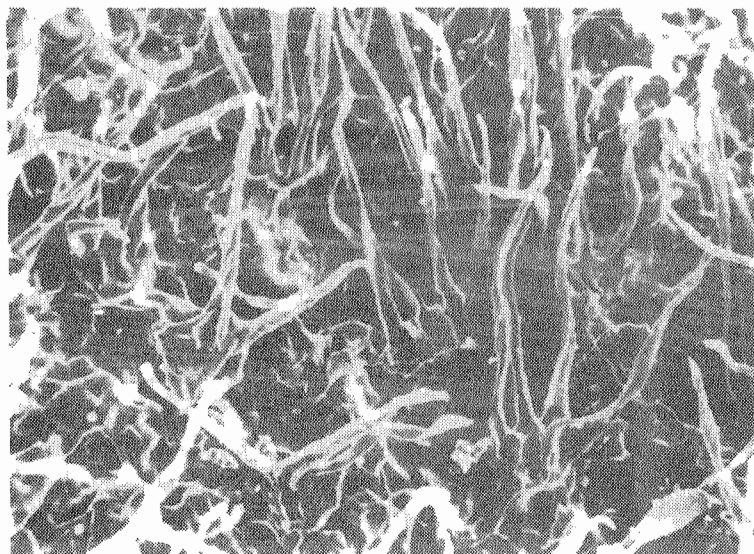


Fig. 9. *Hibiscus cardiophyllus* A. Gray SEM, Distribution of hairs, x 1000.

one or three layers of cells; PL, 165 μm , lumen in middle of cell; IM, 1-7 layers; FL, present.

Hibiscus esculentus L. Accession: K/88 GM: L, 3-6 mm; C, BL and GR; S, P; FP; CO, SF. H: not present. T: OE, one or many layers of cells; PL, 195 μm , lumen in middle of cell; IM, 7-15 layers; FL, present.

Hibiscus furcellatus Lam. (Fig. 10) Accession: K/33 GM: L, 2.5 mm; C, BL and BR; S, CU; FP. H: not present. T: OE, one layer of fused cells; PL, 130 μm , lumen almost throughout cell; IM, 1 layer; FL, present.

Hibiscus hamabo Sieb. & Zucc. Accessions: K/67, K/183 GM: L, 3-4 mm; C, BR; S, CU; FP; CO, SF. H: Unicellular, single and double; slightly pointed; 1000-3460, a. 1780 μm . T: OE, one or two layers of cells; PL, 60 μm , lumen in upper 1/3 of cell; IM, 1-6 layers; FL, present.

Hibiscus intermedius Hochst. ex T. Anders. (Fig. 11) Accession: K/68 GM: L, 2.5 mm; C, BL, S, CU; FP; CO, SF. H: Unicellular, single and up to 9 in a group; pointed; 170-235, a. 190 μm . T: OE, one layer of cells; PL, 125 μm , lumen almost throughout cell; IM, 1-5 layers; FL, present.

Hibiscus lindleyi Wall. (= *H. radiatus* Cav.) Accession: K/57 GM: L, 4 mm; C, BL, BR and G; S, CU; FP; CO, SF. H: Unicellular, single and up to 13 in a group; pointed; 210-420, a. 290 μm . T: OE, one or two layers of cells, cells below hairs elongated radially; PL, 170 μm , lumen almost throughout cell; IM, 1-6 layers; FL, present.

Hibiscus manihot L. Accessions: K/69, K/135, K/167, K/242. GM: L, 3 mm; C, BL and BR; S, CU; FP; CO, SF. H: Unicellular, single and double; pointed; 70-230, a. 150 μm . T: OE, one layer of cells; PL, 185 μm , lumen in middle of cell; IM, 1-6 layers; FL, present.

Hibiscus militaris Cav. Accession: K/184 GM: L, 3 mm; C, RB; S, CU; FA; CO, SF. H: Unicellular, single and up to 5 in a group; pointed; 110-525, a. 315 μm . T: OE, one layer of cells; PL, 150 μm , lumen in upper 1/3 of cell; IM, 1 layer; FL, present.

Hibiscus moscheutos L. Accessions: K/70, K/89, K/136 GM: L, 3 mm; C, BL and BR; S, CU; FP; CO, SF. H: Unicellular, single and up to 5 in a group; bun-shaped; 45-60, a. 55 μm . T: OE, one or two layers of cells; PL, 110 μm , lumen in upper 1/3 of cell; IM, 1-5 layers; FL, present.

Hibiscus mutabilis L. Accession: K/185 GM: L, 2 mm; C, BL; S, CU; FP; CO, SF. H: Unicellular, single and double; bun-shaped and pointed; 70-770, a. 420 μm . T: OE, one or two layers of cells; PL, 115 μm , lumen in upper 1/3 of cell; IM, 1-7 layers; FL, present.

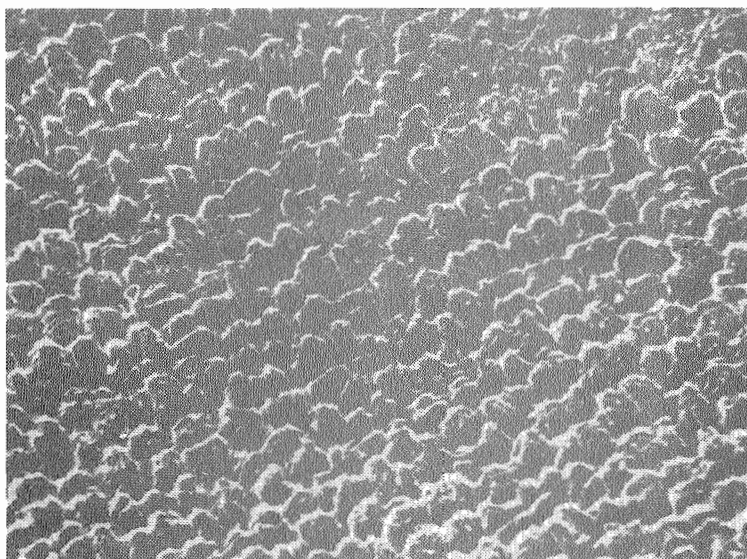


Fig. 10. *Hibiscus furcellatus* Lam. SEM, Epidermal cells, x 1000.

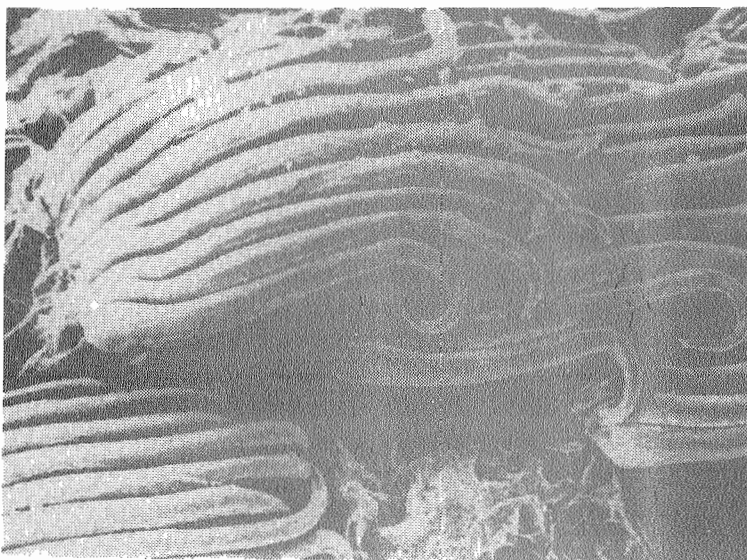


Fig. 11. *Hibiscus intermedius* Hochst. ex T. Anders. SEM, Distribution of hairs, x 1000.

Hibiscus mutabilis L. var. *versicolor makino* Accession: K/186 GM: L, 2.5 mm; C, BL and BR; S, CU; FP; CO, SF. H: Unicellular, single and double; pointed; 140-770, a. 455 μm . T: OE, one or two layers of cells; PL, 120 μm , lumen in upper 1/3 of cell; IM, 1-7 layers; FL, present.

Hibiscus sinosyracus L. H. Bailey Accession: K/71 GM: L, 4 mm; C, BL and BR; S, CU; FP; CO, SF. H: Unicellular, single and up to 7 in a group; pointed; 450-2380, a. 1415 μm . T: OE, one or two layers of cells; PL, 60 μm , lumen in upper 1/3 of cell; IM, 1-6 layers; FL, present.

Hibiscus sororius L. Accession: K/58 GM: L, 1 mm; C, BL; S, CU; FP; CO, SF. H: Uni- and bi-cellular, single and up to 5 in a group; bun-shaped and pointed; 45-70, a. 55 μm . T: OE, one layer of cells; PL, 100 μm , lumen in upper 1/3 of cell; IM, 1-3 layers; FL; present.

Hibiscus trionum L. Accessions: K/3, K/34, K/101, K/138, K/157, K/168, K/188, K/243. GM: L, 2 mm; C, BL, BR and OG; S, P; FA; CO, SF. H: Unicellular, single and double; bun-shaped; 35-55, a. 45 μm ; in surface view a. 60 μm . T: OE, one or two layers of cells; PL, 100 μm , lumen in upper 1/3 of cell; IM, 1-15 layers; FL, present.

Lagunaria patersonii G. Don Accession: K/72 GM: L, 5 mm; C, BL and G; S, P; CO, SF. H: not present. T: OE, one or many layers of cells (cells with thickened inner tangential and radial walls); PL, 195 μm , lumen in upper 1/3 of cell; IM, 1-7 layers; FL, present.

Discussion

An account of the seed structure of 23 species of the Malvaceae have been presented in this study. The taxa studied have not indicated a remarkable differentiation in structure but critically the seed anatomy regards the family as a natural group. Variation between the genera, other than *Gossypium*, *Thespesia* and *Lebronnecia* (Khushk & Vaughan, 1985), concerns mainly the seed hairs and the length of the palisade cells. In the present investigation, the seed hairs have been described as bun-shaped or pointed but there is some evidence that these are developmental stages (Figs. 7, 8) and therefore, for the purpose of taxonomy, these hair forms must be treated with caution. Apart from the actual form of the hair, of the various genera investigated, *Hibiscus* appears somewhat distinct in that it shows a marked grouping of hairs with a range of 2-13 hairs in each group (Figs. 7, 11). The length of the palisade cells varies from 60 μm in *Hibiscus hamabo* to 205 μm in *H. cardiophyllus*. The division of the tribe into various genera were based on various characters of the flower and fruit. Seed structure, as described in this investigation, does not in general provide information for the division of the Hibisceae into genera except that *Hibiscus* shows hairs whereas *Lagunaria* have no hairs. However, the anatomical studies carried out show that the tribe Hibisceae is a natural unit.

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