

SEED STRUCTURE IN RELATION TO THE TAXONOMY OF THE  
ABUTILEAE (*ABUTILON*, *ANODA*, *MODIOLA*, *SIDA*,  
*SPHAERALCEA* AND *UROCARPIDIUM*)

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Abstract

The general morphology and structure of the seeds of 17 species of the Abutileae (Malvaceae) have been studied using light and scanning electron microscopy. Relevance of seed structure to the tribal divisions of the family is discussed.

Introduction

The family Malvaceae consists of a natural group of plants and subsequently the differences among its genera and species are slight. The division of the family into tribes and subtribes has been based on various characters of the flower and fruit. Work with the light microscope of seed structure is significant to systematic botanists. The seeds of Abutileae develop from campylotropous ovules. Hairs have been found to be present in some of the genera investigated, whereas others do not possess hairs. The different parts of the seed coats have been identified. The epidermal cells of the testa are of two types i.e. thick-walled or thin-walled. In this region, the parenchyma zone varies with regard to the number of cell layers. The epidermis may be limited internally by a clear layer of cells, sometimes with calcium oxalate crystals. The above described layers develop from the outer integument of the ovule. The outer epidermis of the inner integument forms the highly characteristic palisade or malpighian cells, the length of the palisade layer differs from taxon to taxon. The cell lumen is only obvious in the upper portion of the palisade cell and a 'light line' can usually be seen. As far as the rest of the testa, which consists essentially of parenchyma layers, is concerned, 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 have been found to be absent in embryo.

The published work on the seed anatomy of Abutileae includes: *Abutilon avicennae* Gaertn. (Syn. *A. theophrasti* Medic.): (Kondo, 1925; Vaughan, 1970; Corner, 1976); *A. indicum* G. Don. (Rao, 1955); *A. theophrasti* Medic. (Reeves, 1936; Winter, 1960a,b; Corner, 1976). *Anoda parviflora* (Guignard, 1893); *Modiola caroliniana* (L.) G. Don (Reeves, 1936a); *Sida cordifolia* L. (Rao, 1955); *S. hermaphrodita* Rusby (Savchanko &

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Dmitrashko, 1973; Dmitrashko, 1974); *S. rhombifolia* L. (Reeves, 1936a); *S. veronicaefolia* L. (= *S. humilis* Willd.) (Rao, 1955).

The present investigation is a study of the seed structure of 6 genera and 17 species of the Abutilaceae, using light microscopy and the scanning electron microscope. The structural variation described is related to the taxonomy of the tribe.

### Material and Methods

Seed samples were obtained from worldwide. For identifying the unauthenticated material seeds were grown at the Chelsea Physic Garden and identified against dried specimens in the Herbarium of the Natural History Museum, London. Herbarium sheets were prepared of all material grown. The seeds investigated have been described according to the classification by Hutchinson (1967). Methods used for anatomical studies have been described earlier (Khushk, 1985).

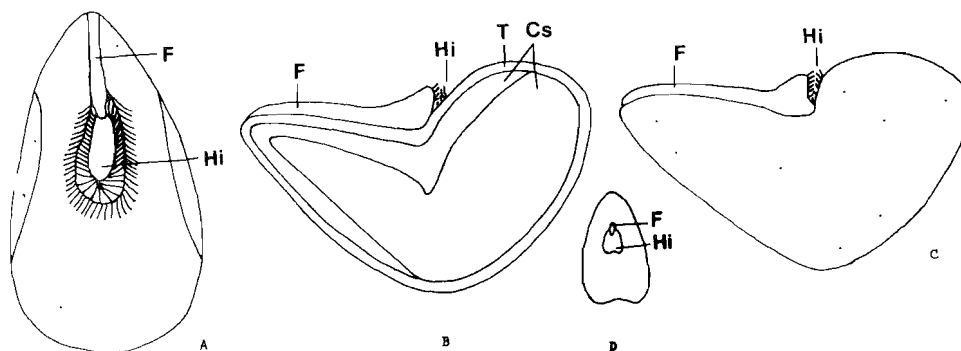
### Results

The seed of each species has been described with regard to its general morphology and the internal structure. Variation was found with seed length, colour and shape. Only one shape i.e. cuneiform (wedge-shaped) has been recognized. The funicle is either persistent or absent. In vertical section, the cotyledons are seen to be slightly folded. The hairs on the seed surface are of multi-structure and variously distributed. In microscopic structure, the testa has been identified with the following regions: *Outer integument*: the epidermis. *Inner integument*: the palisade layer (outer epidermis); the mesophyll; the fringe layer (inner epidermis).

The gossypol cavities are absent in the embryo. Occasionally, because of the pre-treatment required for observations with the SEM, artefacts are shown by the hairs (Figs. 6, 9). The seed characters of each species have been described using some of the abbreviations:

- GM: General morphology,
- L: Seed length
- C: Colour; BL: Black, BR: Brown, LB: Light Brown.
- S: Shape; CU: Cuneiform
- FA: Funicle absent
- FP: Funicle persistent
- CO: Cotyledons, SF: Slightly folded.
- H: Hairs.

The minimum and maximum length is given for hairs, together with the average (a).



Figs. 1

- A: *Abutilon avicennae* Gaertn. Front view of hilum showing large hairs, x 30.  
 B: *Abutilon avicennae* Gaertn. Section through seed showing foldings of cotyledons, x 30.  
 C: *Abutilon avicennae* Gaertn. Side view of hilum, x 30.  
 D: *Modiola caroliniana* G. Don. Front view of hilum, x 30.  
 Cs, Cotyledons; F, Funicle; Hi, Hilum; T, Testa.

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.

*Abutilon avicennae* Gaertn. (Fig. 1A, B & C).

Accessions: K/129, K/152.

GM: L, 3mm; C, BL; S, CU; FP; CO, SF.

H: Unicellular, pointed; 70–95, a. 85  $\mu\text{m}$ ; around hilum, very long hairs present, a. 235  $\mu\text{m}$ .

T: OE, one or two layers of cells, cells below hairs elongated radially; PL, 145  $\mu\text{m}$ , lumen in upper 1/3 of cell; IM, 2–3 layers; FL, present.

*Abutilon theophrasti* Medic. (Fig. 2)

Accessions: K/23, K/172, K/189, K/190, K/191, K/233.

GM: L, 3mm; C, BL, S, CU, FP; CO, SF.

H: Unicellular, pointed; 55–130, a. 95  $\mu\text{m}$ ; around hilum, very long hairs present, a. 275  $\mu\text{m}$ .

T: OE, one layer of cells, cells below hairs elongated radially; PL, 140  $\mu\text{m}$ , lumen in upper 1/3 of cell; IM, 2–3 layers; FL, present.

*Abutilon fruticosum* Guill. & Perr.

Accession: K/213.

GM: L, 2mm, C, BR; S, CU; FP; CO, SF.

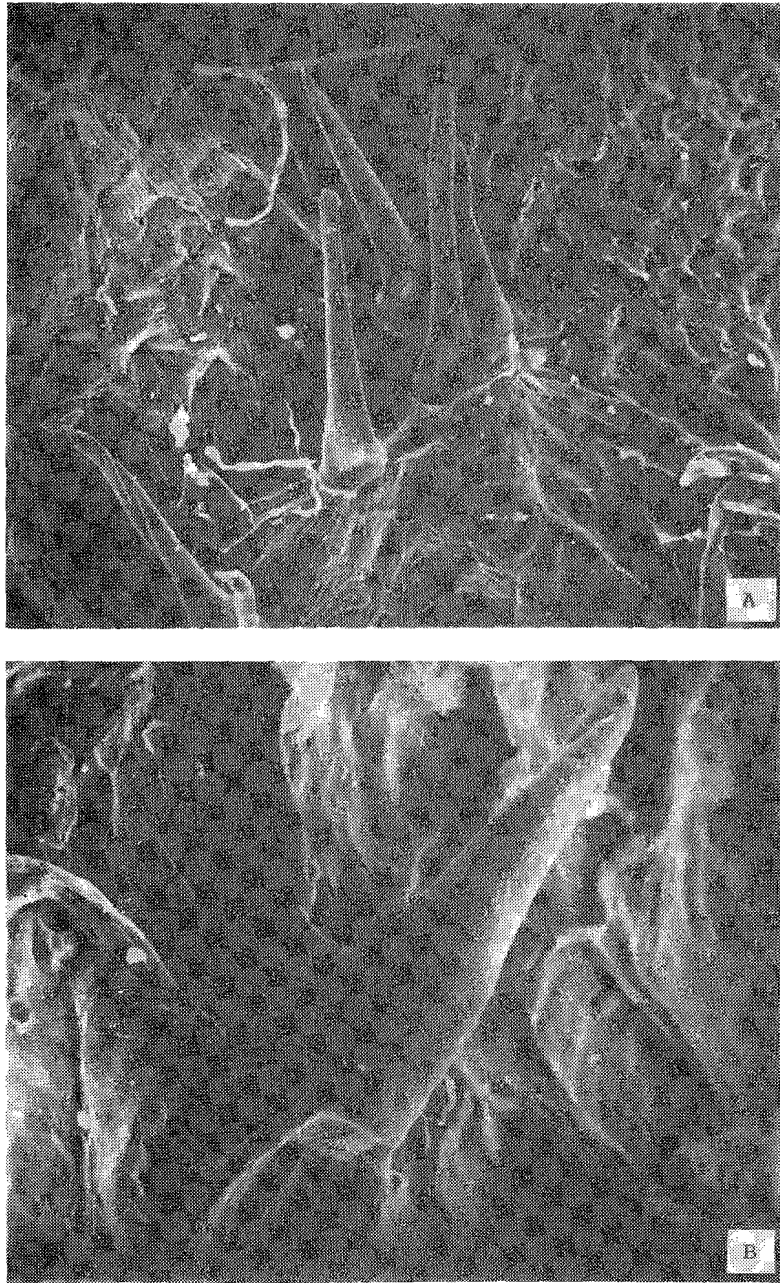


Fig. 2. *Abutilon theophrasti* Medic. SEM, A. distribution of hairs, x 300. B. A hair base, x 600.

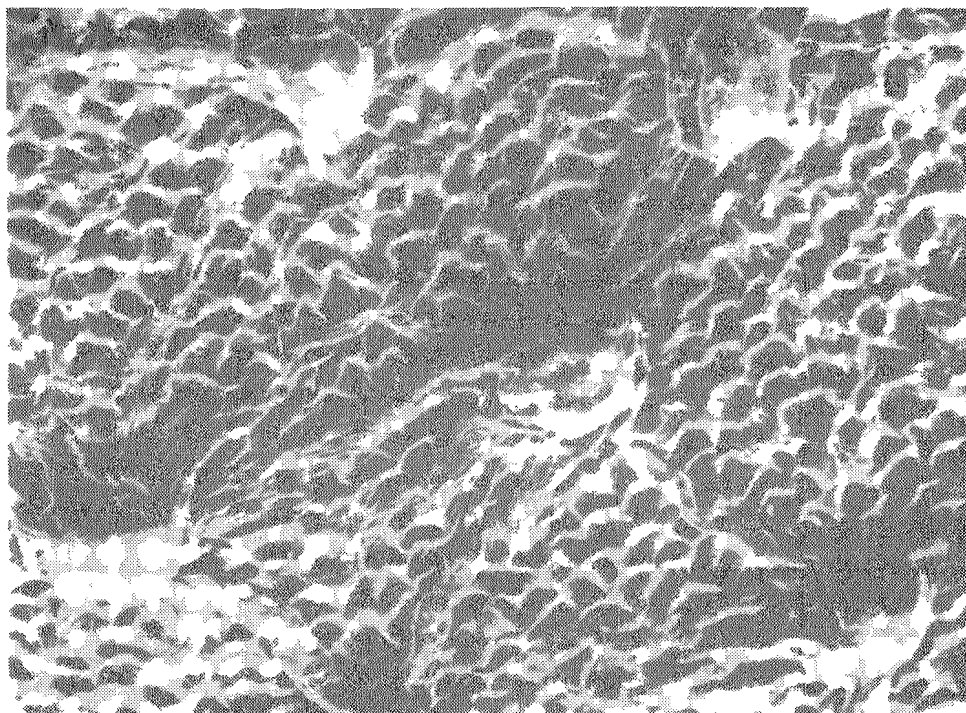


Fig. 3. *Abutilon indicum* Sweet. SEM, Distribution of hairs, x 1300.

H: Unicellular, single and double; bun-shaped and pointed; 55–145, a. 105  $\mu\text{m}$ .

T: OE, one or two layers of cells, cells below hairs elongated radially; PL, 100  $\mu\text{m}$  lumen in upper 1/3 of cell; IM, 1–5 layers; FL, present.

*Abutilon indicum* Sweet (Fig. 3)

Accessions: K/162, K/225.

GM: L, 2mm; C, BL; S, CU; FP; CO, SF.

H: Unicellular, bun-shaped; 35  $\mu\text{m}$ .

T: OE, one layer of cells, cells below hairs elongated radially; PL, 115  $\mu\text{m}$ , lumen in middle of cell; IM, 1–3 layers; FL, present.

*Abutilon molle* Sweet (Fig. 4)

Accession: K/64

GM: L, 2mm; C, BL and BR; S, CU; FP; CO, SF.

H: Unicellular, pointed; 175–205, a. 200  $\mu\text{m}$ .

T: OE, one layer of cells; PL, 90  $\mu\text{m}$ , lumen in middle of cell; IM, 1–2 layers; FL, present.

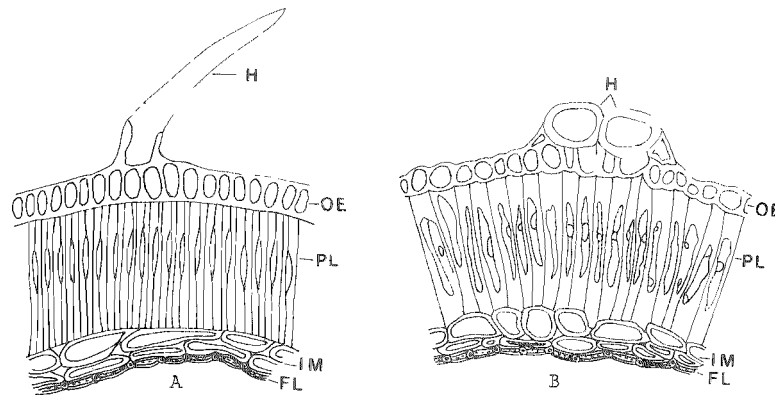


Fig. 4.

A: *Abutilon molle* Sweet. Transverse section of seed coat, x 470.

B: *Anoda dilleniana* Cav. Transverse section of seed coat, x 470.

FL, Fringe layer; H, Hairs, IM, Mesophyll of inner integument; OE, Outer epidermis developed from outer epidermis of outer integument; PL, Palisade layer, developed from outer epidermis of inner integument.

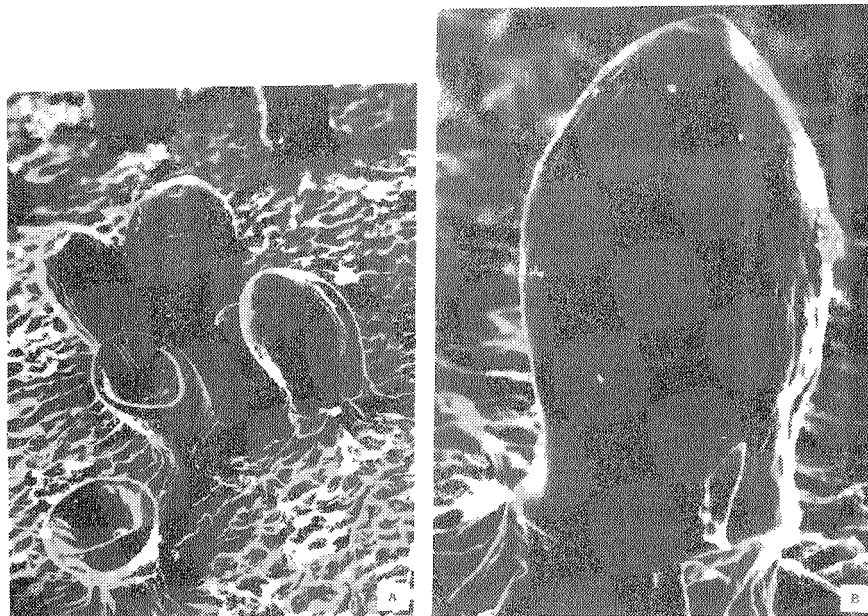


Fig. 5. *Abutilon ochsenii* Phil. SEM, A Distribution of hairs, x 1000. B, A hair base, x 1500.

*Abutilon ochsenii* Phil. (Fig. 5)

Accession: K/1

GM: L, 2mm; C, BL and BR; S, CU; FP; CO, SF.

H: UNicellular, single and double, pointed and club-shaped; 70–205, a. 120  $\mu\text{m}$ .T: OE, two layers of cells; PL, 140  $\mu\text{m}$ , lumen in upper 1/3 of cell; IM, 3 layers; FL, present.*Abutilon sellovianum* Regel (Fig. 6)

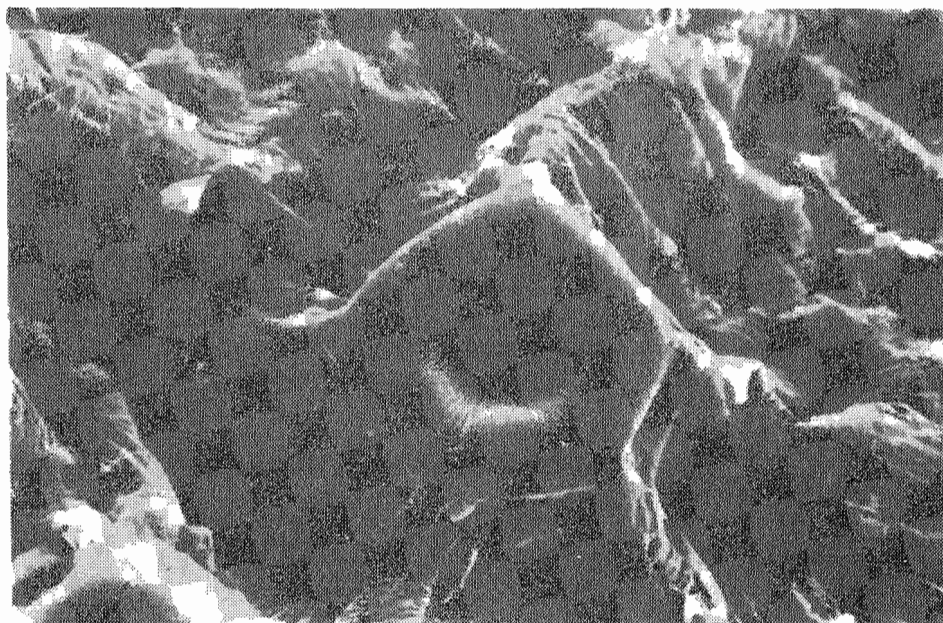
Accession: K/47.

GM: L, 2mm; C, BL and LB; S, CU; FP; CO, SF.

H: Unicellular, bun-shaped; 35  $\mu\text{m}$ .T: OE, one layer of cells, cells below hairs elongated radially; PL, 95  $\mu\text{m}$ , lumen in middle of cell; IM, 2–3 layers; FL, present.*Abutilon sonneratium* Sweet

Accession: K/65

GM: L, 2mm; C, BL and BR; S, CU; FP; CO, SF.

H: Unicellular, bunshaped; 35  $\mu\text{m}$ .T: OE, one layer of cells, cells below hairs elongated radially; PL, 95  $\mu\text{m}$ , lumen in upper 1/3 of cell; IM, 1 layer; FL, present.Fig. 6. *Abutilon sellovianum* Regel, SEM, A hair base, x 2000.

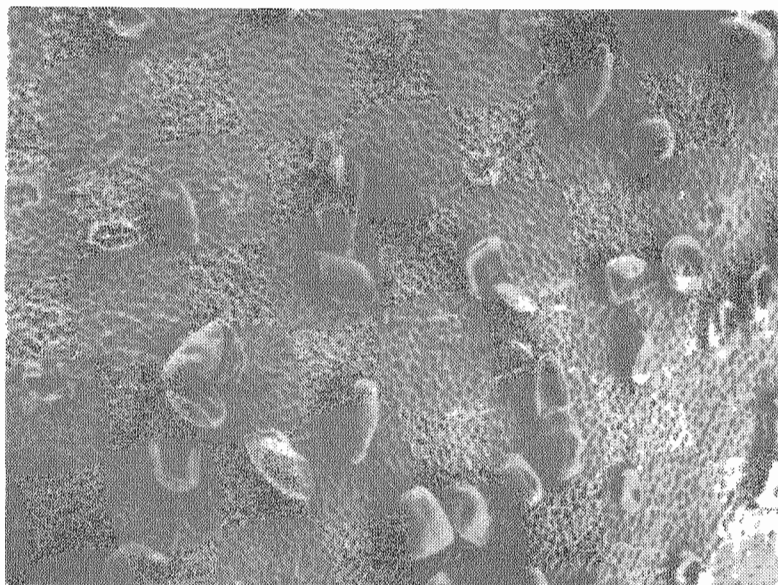


Fig. 7. *Abutilon vitifolium* Presl. SEM, A hair base, x 2000.

*Abutilon vitifolium* Presl (Figs. 7, 8A)

Accession: K/2

GM: L, 2–2.5mm, C, BL and BR; S, CU; FP; CO, SF.

H: Unicellular, single and double, club-shaped; 192–227, a. 210  $\mu\text{m}$ .

T: OE, one or two layers of cells; PL, 130  $\mu\text{m}$ , lumen in upper 1/3 of cell; IM, 3–7 layers; FL, present.

*Anoda cristata* Schlecht.

Accessions: K/29, K/238.

GM: L, 3mm; C, BL and BR; S, CU; FP; CO, SF.

H: Unicellular, bun-shaped and slightly pointed; 60–80, a. 70  $\mu\text{m}$ .

T: OE, one layer of cells; PL, 125  $\mu\text{m}$ , lumen almost throughout cell; IM, 1–2 layers; FL, present.

*Anoda cristata* Schlecht var. *brachycantha*

Accession: K/28

GM: L, 3mm; C, BL and BR, S, CU; FA: CO, SF.

H: not present.

T: OE, not present PL, 260  $\mu\text{m}$ , position of lumen variable. IM, 1–2 layers; FL, present.



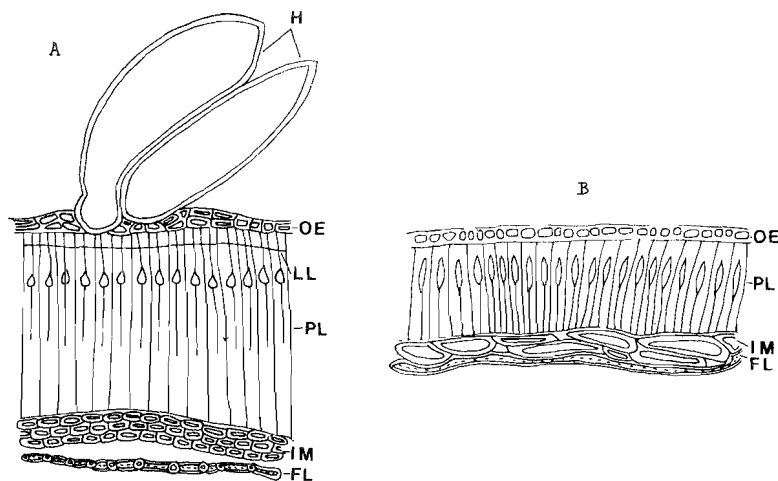


Fig. 8.

A: *Abutilon vitifolium* Presl. Transverse section of seed coat, x 470.

B: *Urocarpidium peruvianum* (L.) Krapov. Transverse section of seed coat, 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; PL, Palisade layer, developed from outer epidermis of inner integument.

*Anoda dilleniana* Cav. (Fig. 5B)

Accession: K/133

GM: L, 3mm; C, BL and BR; S, CU; FA; CO, SF.

H: Unicellular, bun-shaped; 50–80, a. 65  $\mu$ m.

T: OE, one layer of cells; cells below hairs elongated radially; PL, 130  $\mu$ m, lumen almost throughout cell; IM, 2–5 layers; FL, present.

*Anoda wrightii* A. Gray

Accession: K/30

GM: L, 2mm; C, BL and BR; CU; FP; CO, SF.

H: Unicellular, slightly pointed; 70–85, a. 75  $\mu$ m.

T: OE, disorganised; PL, 135  $\mu$ m, lumen almost throughout cell; IM, 2 layers; FL, present.

*Modiola carolimiana* G. Don (Syn. *M. multifida* Moench) (Fig. 1D)

Accessions: K/45, K/256.

GM: L, 1mm; C, BR; S, CU; FP; CO, SF.

H: not present.

T: OE, one layer of cells; PL, 130  $\mu$ m, lumen in upper 1/3 of cell; IM, 1 layer; FL, present.

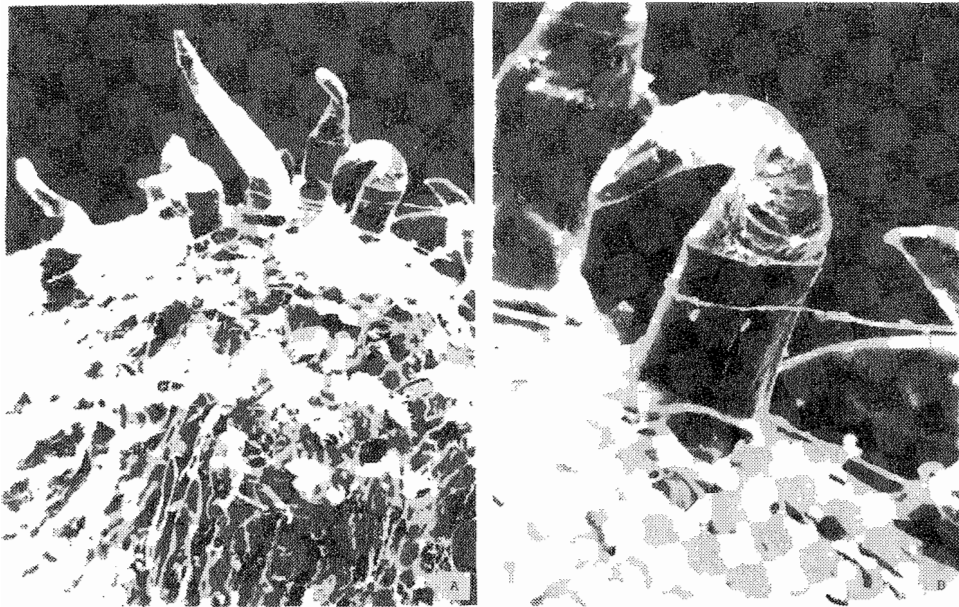


Fig. 9. *Sphaeralcea rivularis* Torr. ex A. Gray. SEM, A. Hairs on the upper end of seed, x 1000. B. Bases of hairs, x 3000.

*Sida hermaphrodita* Rusby

Accessions: K/12, K/171, K/178, K/212.

GM: L, 1.5–2mm; C, BL and BR; S, CU; FP; CO, SF.

H: not present.

T: OE, one layer of cells; PL, 85  $\mu$ m, lumen in middle of cell; IM, 1–2 layers; FL, present.

*Sphaeralcea rivularis* Torr. ex A. Gray (Fig. 9)

Accession: K/63.

GM: L, 1mm; C, BR; S, CU; FP; CO, SF.

H: unicellular, hair shaped and pointed, 1000–3000, and 2000  $\mu$ m.

T: OE, one layer of cells; PL, 55  $\mu$ m, lumen in middle of cell; IM, 1–2 layers; FL, present.

*Urocarpidium peruvianum* (L.) Krapov. (Fig. 8B)

Accessions: K/14, K/27, K/46.

GM: L, 1–1.5mm; C, BR; S, CU; FP; CO, SF.

H: not present.

T: OE, one layer of cells; PL, 75  $\mu$ m, lumen in middle of cell; IM, 1–2 layers; FL, present.

### Discussion

The seed structure of 17 species of Abutileae has been related to the taxonomy of the tribe. The characters of the flower and fruit of the Abutileae show that the tribe is a collection of a natural group of plants. Likewise, the seed anatomy supports the concept of the tribe as a natural unit. Little variation in structure is shown by the various accessions of each species. Variation between the genera 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 and club-shaped with pointed apex but there is some evidence that these are developmental stages (Figs. 4, 8, 9) and therefore, for the purpose of taxonomy, these hair forms must be treated with caution. The length of the palisade cells varies from 55  $\mu\text{m}$  in *Sphaeralcea rivularis* to 260  $\mu\text{m}$  in *Anoda cristata* var. *brachycantha*.

The division of the tribe into various subtribes and genera were based on various characters of the flower and fruit (Hutchinson, 1967). Seed structure of the Abutileae investigated, does not in general provide information for the division of the tribe into subtribes and genera except that the genera like *Abutilon*, *Anoda* and *Sphaeralcea* possess hairs whereas *Modiola*, *Sida* and *Urocarpidium* have no hairs. However, the anatomical studies carried out indicate that the tribe Abutileae is a natural taxon.

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