

A SCANNING ELECTRON MICROSCOPE SURVEY OF SEED SURFACE MORPHOLOGY OF SOME TAXA OF MALVACEAE

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ABSTRACT

Seeds of 54 taxa under 17 genera of the family Malvaceae were examined with scanning electron microscope (SEM) and compared. The variation in seed coat pattern differs from species to species even in infraspecific level. *Malva*, the type genus of this family shows rectangular spermoderm cells and these are arranged in scalariform pattern but in *M. mauritiana*, the epidermal cells coincidentally have developed irregular surface. The difference between the genera *Alcea* and *Althaea*, the separation of *Dicellostyles jujubifolia* from the genus *Kydia*, placing of *Urena sinuata* as subspecies of *U. lobata* and establishing of *Abelmoschus tuberculatus* var. *deltordefolius* have been supported.

INTRODUCTION

The family Malvaceae comprises of 88 genera and c. 2300 species distributed in tropics, subtropics and temperate regions of the World. In India this family is represented by 24 genera and c. 104 species. This study of seed morphology in Malvaceae was made in conjunction with the revisionary work now completed for Flora of India.

Several studies on the anatomy of the seed and seed coat of Malvaceae based on light microscopic study have been reported (Winter, 1960; Singh, 1967; Mohan Rao, 1978; Kumar *et al.* 1985, 1986). But the seed surface morphology of Malvaceae based on scanning electron microscope (SEM) have not previously been studied in detail. A recent review on spermoderm patterns by Brisson & Peterson (1976) amply justify that investigations using SEM may be useful in the understanding of systematics, ecology, genetics and evolution of plants.

In order to examine the characters of spermoderm and to help the taxonomic disposition of different taxa in certain cases, SEM studies of spermoderm of the seeds of some taxa of the family Malvaceae in India have been undertaken.

MATERIALS AND METHODS

The seeds of 54 taxa of Malvaceae have been examined by scanning electron microscope (SEM). Seeds for this study were obtained from herbarium specimens at CAL. They were taken directly from fruit. Dry cleaned mature seeds were directly mounted on the adhesive tapes placed on the stubs and subsequently they were Palladium gold coated. Surface pattern of the seeds were studied in different magnifications and wherever possible minimum of three seeds were examined and photographs taken. Scanning of all the materials were done in Philips, SEM 500 scanning electron microscope.

Voucher information for the taxa of Malvaceae studied here. Taxa are arranged alphabetically. All collections are deposited in CAL

Taxon	Collection data	Taxon	Collection data
<i>Abelmoschus angulosus</i>	Kerala, Palghat Dt. 21.10.1963, <i>Joseph</i> 17813	<i>H. lunariifolius</i>	Karnataka, Supa, N. Kanara, 20.11.1887, <i>Talbot</i> 1585
<i>A. crinitus</i>	Uttar Pradesh, without precise locality, <i>Anonymous</i> s.n.	<i>H. macrophyllus</i>	Assam, 1891, <i>King's collector</i> s.n.
<i>A. ficulneus</i>	Rajasthan, Govatadam, Bhilwara, 2.10.78, <i>Singh</i> 5711	<i>H. panduraeformis</i>	Madhya Pradesh, Amarpatan, Biladilla, 8.2.63, <i>Panigrahi</i> 6736
<i>A. manihot</i> ssp. <i>tetraphyllus</i>	West Bengal, Birati, 24-Parganas, 4.11.65, <i>Roychowdhury</i> 30	<i>H. radiatus</i>	West Bengal, without precise locality, Nov 15, 1898, <i>Prair</i> s.n.
<i>A. tuberculatus</i> var. <i>tuberculatus</i>	Uttar Pradesh, Shaharanpur, <i>Anonymous</i> s.n.	<i>H. sabdariffa</i>	West Bengal, Kardapara, Bankura, 24.12.1958, <i>Sengupta</i> 2020
<i>A. tuberculatus</i> var. <i>deltoideifolius</i>	Rajasthan, Jhalawar, 21.9.64, <i>Wadhwa & Verma</i> 7524.	<i>H. surattensis</i>	Tamil Nadu, Mainfalls, Courtallam, 453 m, 16.12.1957, <i>Subramanyam</i> 4947
<i>Abutilon bidentatum</i>	Rajasthan, Jodhpur, March 1868, <i>King</i> s.n.	<i>H. tiliaceous</i>	North Nicobar, 20.8.74, <i>Chakraborty</i> 2114
<i>A. hirtum</i>	Bihar, Palamau, Chotanagpur Dec. 1880, <i>Gamble</i> s.n.	<i>Kydia calycina</i>	Madhya Pradesh, Band R.F. Saugor dt, 30.10.1960, <i>Balakrishnan</i> 11369
<i>A. indicum</i>	Tamil Nadu, Bunds of Vedanthangal (Chingleput Dt.), 25.1.76, <i>A. N. Henry</i> 47026	<i>K. glabrescens</i>	Arunachal Pradesh, Shoe-lingoreyi, Lohit F.D., 30.11.1957, <i>Panigrahi</i> 10858
<i>A. persicum</i>	Tamil Nadu, Coimbatore, 2.3.78, <i>Hore</i> 598	<i>Lavatera cachemiriana</i>	Kashmir, Sonamarg, <i>Clarke</i> s.n.
<i>A. ramosum</i>	Kerala, Kavalay Cochin, Nov. 1910, <i>Meebold</i> 12383	<i>Malachra capitata</i>	West Bengal, Dum Dum Cantt., 8.11.59, <i>Chatterjee</i> 7
<i>A. theophrasti</i>	Kashmir, <i>Meebold</i> 3662	<i>Malva mauritiana</i>	Madhya Pradesh, Sadarpur, Indore, 10.9.64, <i>Arora</i> 5845
<i>Alcea rosea</i>	Uttar Pradesh, Dehra Dun, 23.2.1870, <i>King</i> s.n.	<i>M. neglecta</i>	Kashmir, Sonamarg, 1876, <i>Clarke</i> 30881
<i>Althaea officinalis</i>	Kashmir, <i>Falconer</i> 281	<i>M. parviflora</i>	Rajasthan, Ghativill, Tonk dt. 17.2.1973, <i>Shetty</i> 568
<i>Decaschistia crotonifolia</i>	Tamil Nadu, Mudumalai R.F. Nilgiri, 18.11.1958, <i>Sebastine</i> 7339	<i>M. sylvestris</i>	Uttar Pradesh, Lalitpur, 9.12.1910, <i>Kalkaprasad</i> 34853
<i>D. trilobata</i>	Karnataka, Gessappa falls, Oct 1908, <i>Meebold</i> 9645	<i>M. verticillata</i>	Nagaland, Naga Hills, 1899, <i>Prair's collector</i> 714
<i>Dicellostyles jujubifolia</i>	Meghalaya, Khasia, <i>Griffith</i> 1270	<i>Pavonia grewioides</i>	Gujarat, Jamnagar — Rozibuder Rd. 25.9.1964, <i>S.R. Rolla</i> 102979
<i>Fioria vitifolia</i>	Andhra Pradesh, Baleivalle, July 1885, <i>Gamble</i> 16560	<i>P. odorata</i>	Tamil Nadu, Maruthamalai, Coimbatore, Dt 653 m, 7.8.1956, <i>Sebastine</i> 500
<i>Hibiscus caesius</i>	Arunachal Pradesh, Shoe-lingoreyi, Lohit F.D., 30.11.1957, <i>Panigrahi</i> 10898		
<i>H. cannabinus</i>	West Bengal, Sahibgung, <i>Kurz</i> s.n.		

Taxon	Collection data
<i>Pavonia repanda</i>	West Bengal, Darjeeling 2.12.1857, <i>Thomson s.n.</i>
<i>P. zeylanica</i>	Rajasthan, Jodhpur, 14.10.1976, <i>A.N. Singh</i> 3255
<i>Senra incana</i>	Gujarat, Dwarka, Saurashtra, 26.3.1964, <i>Mukherjee</i> 2267.
<i>Sida acuta</i>	Kerala, Triveni Pamba, 2.9.1977, <i>Nair</i> 50811
<i>S. cordata</i>	Bihar, Ladaburu, 28.12. 1960, <i>G.V.S. Rao</i> 22771
<i>S. cordifolia</i>	Uttar Pradesh, Mirzapur, 12.10.69, <i>Panigrahi</i> 12473
<i>S. mysorensis</i>	Maharashtra, Tokavada Range, 19.11.1968, <i>Billore</i> 115931
<i>S. ovata</i>	Rajasthan, Jodhpur, 9.10. 76, <i>A.N. Singh</i> 3177
<i>S. rhombifolia</i> ssp. <i>rhombifolia</i> var. <i>rhombifolia</i>	Maharashtra, Dolkhamb, 14.10.1967, <i>Billore</i> 11823
<i>S. rhombifolia</i> ssp. <i>rhombifolia</i> var. <i>scabrida</i>	Tamil Nadu, Nilgiri, Ootacamund, 6.12.1878, <i>King s.n.</i>
<i>S. rhombifolia</i> ssp. <i>retusa</i>	Andhra Pradesh, Bison hill (Godavari agency), 4.12.1902, <i>Barber</i> 5104
<i>S. spinosa</i>	Rajasthan, Bhilwara, 27.9. 78, <i>A.N. Singh</i> 6027
<i>Urena lobata</i> ssp. <i>lobata</i>	Maharashtra, Khandala, 15.11.1961, <i>Ansan</i> 32858
<i>U. lobata</i> ssp. <i>sinuata</i>	Bihar, Baroali, 5.11.1874 <i>Clarke</i> 251546
<i>Wissadula rostrata</i>	West Bengal, Bhedia, 15.3.65, <i>A.K. Dutt</i> 653

DESCRIPTION

Abelmoschus angulosus Wall. ex Wt. & Arn., Prod. Fl. Pen. Ind. Or. 1: 53. 1834.

Seeds 3-4 mm in diameter, more or less globular to reniform, stellate hairy, hairs in concentric rings. Spermoderm cells conspicuous, elongated, mostly hexagonal forming a reticulum, boundaries uniform, surface rugose (Pl. 1 A-B).

A. crinitus Wall. Pl. As. Rar. 1: 89, t. 44. 1830.

Seeds 3-5 mm in diameter, reniform to subglobular, rusty tomentose, verrucate. Spermoderm cell boundaries obliterated due to irregular deposition of the wall materials, surface rugose and sometimes forming irregular reticulation (Pl. 1 C-D).

A. ficulneus (Linn.) Wt. & Arn. ex Wt. Cat. 14. 1833 et in Prod. Fl. Pen. Ind. Or. 1: 53. 1834.

Seeds c. 3 mm in diameter, tomentose by sellate hairs, striated. Spermoderm cells inconspicuous, surface rugose, stellate hairs from elevated tubercular structures. (Pl. 1 E-F).

A. manihot (Linn.) Medic. ssp. *tetraphyllus* (Roxb. ex Hornem) Borss. in Blumea 14: 97. 1966.

Seeds 3-4 mm in diameter, globular to reniform, minute warts and stellate hairs in concentric rings. Spermoderm cell boundaries conspicuous, uniformly thickened, smooth or striated, cell surface smooth. (Pl. 2 A-C).

A. moschatus Medic., Malv. 46. 1787.

Seeds 3-4 mm in diameter, reniform, concentrically ribbed, glabrous. Spermoderm cells conspicuous forming a reticulum, cells angular, boundary walls irregularly thickened, surface rugose. (Pl. 2 D-F).

A. tuberculatus Pal et Singh in Bot. Gaz. 113. 458. 1952.

Seeds c. 3 mm. in diameter, globose-reniform, tubercles in concentric rings, glabrous. Spermoderm cells conspicuous, boundary walls thick forming reticulation, thickening not uniform, sometimes extension of the boundary walls traverse the surface, cell surface rugose. (Pl. 3 A-B).

A. tuberculatus var. *deltoideifolius* Paul et Nayar in Bull. Bot. Surv. India 24 (1-4): 215. 1982.

Seeds 4-5 mm in diameter, more or less globose, stellate hairy, hairs in concentric rings. Spermoderm cells conspicuous arranged in rows, boundary walls more or less uniformly thickened and each cell with

a projection from the boundary wall towards the surface, surface rugose (Pl. 3 C-D).

Abutilon bidentatum A. Rich. Tent. Fl. Abyss. 68. 1847.

Seeds c. 1.5 mm in diameter, reniform, glabrous, hilum with few stellate hairs. Spermoderm cells inconspicuous due to irregular thickening of the cell boundaries and with some alveoli on the ridges, surface, undulate (Pl. 3 E-F).

A. hirtum (Lamk.) Sweet, Hort. Brit. ed. 1 : 53. 1826.

Seeds c. 2.5 mm in diameter, reniform, stellate hairy, hairs more or less in reticulate pattern, hilum with stellate hairs, hairs thick with tuberculate base, extension of the tuberculum traverse the surface. Spermoderm cells more or less obliterate due to more thickened boundary walls forming alveolar structure, boundary walls irregularly thickened, striated (Pl. 4 A-C).

A. indicum (Linn.) Sweet, Hort. Brit. ed. 1 : 54. 1826.

Seeds 2-3 mm in diameter, reniform, glabrescent, hilum with stellate hairs, surface with erect tubercles, apex of the tubercles depressed, extension of the tubercles traverse the surface. Spermoderm cells conspicuous, boundary walls more or less uniformly thickened, striate, surface rugose (Pl. 4 D-F).

A. persicum (Burm. f.) Merr. in Philip, J.Sc. 19 : 364. 1921.

Seeds c. 2 mm diameter, reniform, surface with scattered tubercles, glabrous. Spermoderm cells conspicuous, more or less uniformly thickened forming a rows of alveoles like appearance (Pl. 5 A-B).

A. ramosum (Cav.) Guill et Perr. in Guill. et al., Fl. Senegamb. 1 : 68. 1830.

Seeds c. 2 mm in diameter, reniform, glabrescent. Spermoderm cells not conspicuous, surface with some elevated amorphous structures with some pits encircled by elevated boundaries (Pl. 5 C-D).

A. theophrasti Medic., Malv. 28. 1787.

Seeds c. 3-4 mm across, reniform, gla-

brescent; hilum hairy. Spermoderm cells more or less conspicuous, boundaries not uniform, surface undulate, striated (Pl. 5 E-F.).

Alcea rosea Linn., Sp. Pl. 687. 1753.

Seeds 3-4 mm in diameter, reniform, surface with scattered glandular structures, hilum with some appressed hairs. Spermoderm cells obliterated due to irregular thickening of the boundaries forming a reticulum, reticula roundish to angular, glandular structures are angular and raised (Pl. 6 A-B).

Althaea officinalis Linn., Sp. Pl. 686. 1753.

Seeds 1.5-2.5 mm in diameter, reniform, glabrous, hilum glabrous. Spermoderm cells inconspicuous, surface with irregular ridges and furrows (Pl. 6 E-F).

Decaschistia crotonifolia Wt. & Arn., Prod. Fl. Pen. Ind. Or. 1 : 52. 1834.

Seeds c. 4 mm long and c. 2.5 mm across, reniform, glabrous. Spermoderm cell boundaries obliterated due to irregular thickening forming alveoles (Pl. 6 C-D).

D. trilobata Wt. Ic. v. I. t. 88. 1840.

Seeds c. 5 mm long and c. 3 mm across, reniform, glabrous. Spermoderm cell boundaries obliterated due to irregular thickening forming alveoles (Pl. 7 A-B).

Dicellostyles jujubifolia (Griff.) Benth. in Benth. & Hook. f., Gen. Pl. 1 : 207. 1862.

Seeds c. 4 mm long and c. 3 mm in diameter, reniform, glabrous. Spermoderm cells conspicuous, angular, forming a reticulum, surface with some elevated structures (Pl. 7 C-D).

Fioria vitifolia (Linn.) Mattei, Bol. R. Orto. Bot. Palermo 2 : 71. 1916.

Seeds 2-3 mm in diameter, reniform, glabrous, surface with scattered tubercles. Spermoderm cells inconspicuous, surface irregularly reticulate, tubercles sometimes connected with each other by the extension from each other (Pl. 7 E-F).

Hibiscus caesius Garcke, Bot. Zeit. 7 : 850. 1849.

Seeds *c.* 3 mm in diameter, reniform, hairy, hairs simple, appressed. Spermoderm cells conspicuous, cells angular forming a reticulum, surface undulate, hairs thick with blunt apex (Pl. 8 A-B).

H. cannabinus Linn., Syst. Nat. ed. 10, 2 : 1149. 1759.

Seeds *c.* 7 mm long and *c.* 4 mm in diameter, triangular reniform, surface with minute scales. Spermoderm cells inconspicuous, surface undulate, scales flat, ribbed, apical portion dissected (Pl. 8 C-D).

H. lunariifolius Willd., Sp. Pl. 3 : 811. 1800.

Seeds 2.0-2.5 mm in diameter, reniform, surface sparsely stellate hairy. Spermoderm cells more or less conspicuous, angular, forming a reticulum, surface rugose or undulate, stellate hairs 2-4 armed, thick (Pl. 8 E-F).

H. macrophyllus Roxb. ex Hornem. Hort. Hafn., Suppl. 149. 1819.

Seeds *c.* 5 mm long, reniform with long fulvous hairs along the edge. Spermoderm cells conspicuous, cells mostly square shaped arranged in vertical rows (Pl. 9 A-B).

H. panduraeformis Burm.f., Fl. Ind. 151, t. 47, f. 2. 1768.

Seeds *c.* 2.0-2.5 mm in diameter, reniform, angular, densely stellate hairy. Spermoderm cells conspicuous, angular, forming a reticulum (Pl. 9 C-D).

H. radiatus Cav., Diss. 3 : 150. t. 54. f. 2. 1787.

Seeds *c.* 4 mm in diameter, reniform, scabrous. Spermoderm cells irregular, not conspicuous, surface irregularly reticulate (Pl. 9 E-F).

H. sabdariffa Linn., Sp. Pl. 695. 1753.

Seeds 2-3 mm long, reniform, stellate hairy. Spermoderm cells conspicuous, cells angular forming reticulum (Pl. 10 A-B).

H. surattensis Linn., Sp. Pl. 696. 1753.

Seeds 3-4 mm in diameter, reniform,

surface with scattered scales, scales palmately lobed and each part bending downwards. Spermoderm cells more or less conspicuous, angular, boundary walls irregularly thickened forming reticulum, surface rugose (Pl. 10 C-D).

H. tiliaceus Linn., Sp. Pl. 694. 1753.

Seeds 4-5 mm long, reniform, glabrous, surface with tubercles. Spermoderm cells inconspicuous, surface undulate (Pl. 10 E-F).

Kydia calycina Roxb., Hort. Beng. 50. 1814
nom. nud. et in Pl. Corom. 3 : 11, t. 215. 1819.

Seeds *c.* 3 mm long and *c.* 2 mm in diameter, reniform, surface with concentric ribs. Spermoderm cells conspicuous, angular, forming reticulum, ribs formed by elevated angular cells, boundary walls irregularly thickened (Pl. 11 A-C).

K. glabrescens Mast. in Hook. f., Fl. Brit. Ind. 1 : 348. 1874.

Seeds *c.* 3 mm long and *c.* 2 mm in diameter, reniform, surface with concentric ribs. Spermoderm cell boundaries not so conspicuous as in *K. calycina*, surface irregularly reticulate, ribs formed by elevated angular cells, boundary walls uniformly thickened, cell surface with some elevated structures (Pl. 11 D-F).

Lavatera cachemiriana Camb. in Jacq. Voy. d. l'Inde 4 : 29. t. 32. 1844.

Seeds *c.* 2.5 mm across, reniform, glabrous. Spermoderm cells not so conspicuous, elongated, arranged in parallel rows, boundary walls irregularly thickened, surface rugose (Pl. 12 A-B).

Malachra capitata (Linn.) Linn., Syst. Nat. ed. 12, 2 : 458. 1767.

Seeds *c.* 2.5 mm long, oblong-reniform to sub-reniform, glabrous. Spermoderm cells conspicuous, angular, boundaries uniformly thickened forming a reticulum, surface smooth (Pl. 12 C-D).

Malva mauritiana Linn., Sp. Pl. 689. 1753.

Seeds 1.0-1.5 mm in diameter, reniform,

glabrous. Spermoderm cells inconspicuous, undulate, surface rugose (Pl. 12 E-F).

Malva neglecta Wallr., Syll.Pl. Nov. Ratisbon 1 : 140. 1824.

Seeds c. 1.5 mm in diameter, reniform, glabrous, rugose. Spermoderm cells conspicuous, 3-5 times longer than broad, quadrangular, arranged in scalariform pattern, intercellular boundaries raised and thickened, surface smooth (Pl. 13 A-B).

M. parviflora Linn. in Hojer, Demonstr. Pl. Hort. Ups. 18. 1753.

Seeds c. 1 mm in diameter, reniform, glabrous, rugose. Spermoderm cells conspicuous, shorter than the epidermal cells of *M. neglecta* Wallr. (Pl. 13 C-D).

M. sylvestris Linn., Sp. Pl. 689. 1753.

Seeds 1.5-2.0 mm in diameter, reniform, rugose. Spermoderm cells conspicuous, about two times as long as broad forming a reticulum, boundaries not uniformly thickened, surface rugose (Pl. 13 E-F).

M. verticillata Linn., Sp. Pl. 689. 1753.

Seeds c. 1.5 mm in diameter, reniform, rugose. Spermoderm cells conspicuous, elongated, quadrangular, 3-4 times longer than broad, arranged in longitudinal rows, intercellular walls more thickened, surface with some traversing fibres from the wall (Pl. 14 A-B).

Pavonia grewoides Hochst. ex Boiss. Fl. Or. 1 : 837. 1867.

Seeds c. 1.5 mm in diameter, ovoid-reniform, hairy. Spermoderm cells inconspicuous forming an irregular reticulation, surface undulate, hairs simple with bulbous base (Pl. 14 C-D).

P. odorata Willd., Sp. Pl. 3 : 837. 1800.

Seeds c. 2 mm long, reniform, hairs with tubercled bases arranged in concentric rings. Spermoderm cells inconspicuous, surface with irregular reticulation, rugose, extension of the hair traverse the cell surface (Pl. 14 E-F).

P. repanda (J.E. Sm.) Spreng, Syst. iii. 98. 1828.

Seeds c. 3 mm long and c. 2 mm in diameter, oblong-ovoid, glabrous. Spermoderm cells conspicuous angular, boundary walls irregularly thickened, surface rugose (Pl. 15 A-B).

P. zeylanica (Linn.) Cav., Diss. 3 : 134, t. 48.f. 2. 1787.

Seeds c. 3 mm long and c. 1.5 mm in diameter, reniform, hairs in concentric rings, hairs coiled, extension of the hair bases traverse the surface. Surface reticulate, spermoderm cells conspicuous, angular (Pl. 15 C-D).

Senra incana Cav., Diss. 2 : 83, t. 35.f. 3. 1786.

Seeds c. 2 mm long and c. 1 mm in diameter, hairy, hairs anastomosing with each other (Pl. 15 E-F).

Sida acuta Burm. f., Fl. Ind. 147. 1768.

Seeds c. 2 mm long, reniform, glabrous, hilum with few stellate hairs. Spermoderm cells conspicuous, boundary walls irregularly thickened and sometimes overlapping forming irregular reticulum, cell surface smooth (Pl. 16 A-B).

S. cordata (Burm. f.) Borss. in Blumea 14 : 182. 1966.

Seeds c. 2 mm long and c. 1 mm in diameter, reniform, glabrous. Spermoderm cells conspicuous, angular, forming uniform reticulum, surface smooth (Pl. 16 C-D).

S. cordifolia Linn., Sp. Pl. 684. 1753.

Seeds c. 2 mm in diameter, reniform, glabrous, hilum with few stellate hairs. Spermoderm cells inconspicuous, boundary walls striate and more thickened than *S. cordata* (Pl. 16 E-F).

S. mysorensis Wt. & Arn., Prod. Fl. Pen. Ind. Or. 59. 1834.

Seeds c. 2 mm long, ovoid to obtriangular, glabrous. Spermoderm cells conspicuous, elongated forming a reticulum, boundary walls raised forming ridges and furrows (Pl. 17 A-B).

S. ovata Forssk., Fl. Aegypt.-Arab. 124. 1775.

Seeds c. 2 mm long, reniform, glabrous, hilum with few stellate hairs. Spermoderm cells inconspicuous forming irregular reticulum (Pl. 17 C-D).

Sida rhombifolia Linn. ssp. *rhombifolia* var. *rhombifolia*—*S. rhombifolia* Linn., Sp. Pl. 684. 1753.

Seeds c. 2 mm in diameter, flattened reniform, glabrous, hilum with few stellate hairs. Spermoderm cells conspicuous, angular to roundish forming a reticulum, surface smooth (Pl. 17 E-F).

S. rhombifolia ssp. *rhombifolia* var. *scabrida* (Wt. & Arn.) Mast. in Hook. f., Fl. Brit. Ind. 1 : 324. 1874.

Seeds c. 2 mm in diameter, reniform, glabrous. Spermoderm cells conspicuous, undulate (Pl. 18 A-B).

S. rhombifolia ssp. *retusa* (Linn.) Borss. in *Blumea* 14 : 198. 1966.

Seeds c. 2 mm in diameter, reniform. Spermoderm cells like that of var. *rhombifolia* but the boundary walls of the outer spermoderm cells are more thickened and broad (Pl. 18 C-D).

S. spinosa Linn., Sp. Pl. 683. 1753.

Seeds 1.0-1.5 mm long, reniform, glabrous. Spermoderm cells more or less conspicuous, boundaries more or less uniformly thickened and sometimes overlapping (Pl. 18 E-F).

Urena lobata Linn., Sp. Pl. 692. 1753.

Seeds 2-3 mm across, reniform, minutely hairy, hairs with bulbous base and pointed apex. Spermoderm cells conspicuous, more or less roundish forming a reticulum, boundary walls raised (Pl. 19 A-B).

U. lobata ssp. *sinuata* (Linn.) Borss. in *Blumea* 14 : 142. 1966.

Seeds 2-3 mm across, reniform, hairy, hairs thick with blunt apex. Spermoderm cells like that of ssp. *lobata* but the boundary walls less thickened even reduced to fibres (Pl. 19 C-D).

Wissadula rostrata (Linn.) Presl. ex Thw. En. Pl. Zeyl. 27. 1858.

Seeds c. 2.5-3.0 mm in diameter, obconic to globoid, surface with simple and short stellate hairs. Spermoderm cells more or less conspicuous, angular, surface rugose (Pl. 19 E-F).

DISCUSSION

The basic seed shape in Malvaceae is obovoid to reniform or globular to obconic, smooth or rough, rugose or hairy and exarillate, usually brownish in colour, size ranges from 1 to 5 mm in diameter. The ultrastructure of the spermoderm (testa) of the seeds of different species are variable even at infraspecific level. Spermoderm cells are arranged in reticulate pattern, sometimes the cell boundaries are in full view but are not conspicuous.

In the tribe Hibisceae the ultrastructure of spermoderm of species enumerated above of the genera *Hibiscus*, *Abelmoschus*, *Fioria*, *Kydia* and *Dicellostyles* have been studied. It is seen that the spermoderm cells of the species of *Abelmoschus* are large hexagonal to quadrangular and the boundaries of the epidermal cells are more or less uniformly thickened except in *A. moschatus* but in *A. crinitus*, *A. ficulneus* the epidermal cells are not conspicuous. Paul and Nayar (1984) described *A. tuberculatus* var. *deltoidifolius*. The spermoderm cell boundaries of this variety are more or less uniform and each cell is with a projection from the boundary wall towards the centre of the cell surface but in *A. tuberculatus* var. *tuberculatus* the cell boundaries are not uniformly thickened. In the genus *Hibiscus*, the epidermal cells are smaller in comparison to the *Abelmoschus* and they are angular to undulate (*H. cannabinus*, *H. tiliaceus*). The spermoderm of *Fioria vitifolia* is having some elevated beads and the cells are irregular. The spermoderm cells of *Dicellostyles jujubifolia*, a species previously assigned to the genus *Kydia* are conspicuous, boundaries uniformly thickened and surface with some elevated

structures but in *Kydia calycina* (Type species of *Kydia*) the spermoderm cell boundaries are more thickened and not always uniform.

The spermoderm of *Decaschistia crotonifolia* and *D. trilobata* of the tribe Decaschisteae have shown that in the former species the epidermal cells are sclerenchymatous with uniform boundaries whereas in the latter species the cells are inconspicuous and surface with alveoles.

In the tribe Malveae, the spermoderm cells of the genus *Malva* shows conspicuous rectangular epidermal cells arranged in scalariform pattern, (*M. neglecta*, *M. parviflora*, *M. verticillata*) an unique feature of this genus but in *M. mauritiana* the spermoderm with irregular ridges and furrows. The genus *Alcea* is frequently combined with the genus *Althaea* (De Candolle, 1824; Bentham & Hooker, 1862) but they differ in spermoderm pattern. In both the cases the spermoderm cells are irregular, arranged in reticulate pattern but in *Alcea rosea* (Type species of *Alcea*), the spermoderm with some angular beads which is absent in *Althaea officinalis* (Type species of *Althaea*). In the genus *Abutilon*, the spermoderm of *A. bidentatum* is irregularly thickened with alveoles on the ridges but in *A. ramosum* the surface with elevated amorphous structures and with some

scattered alveoles encircled by raised thick boundaries. In *A. indicum* cell boundaries are uniformly thickened with prominent striations. In the genus *Sida* the spermoderm cells are arranged in reticulate pattern but sometimes it is irregularly thickened (*S. acuta*, *S. cordifolia*, *S. ovata*, *S. rhombifolia* ssp. *rhombifolia* var. *scabrida*). In *S. spinosa* the cell boundaries are overlapping.

In the tribe Ureneae the spermoderm cells of the subspecies of the genus *Urena* is more or less similar but in *U. lobata* ssp. *lobata* the cell boundaries are uniformly thickened but in *U. lobata* ssp. *sinuata* the boundaries are not uniformly thickened even reduced to fibres.

From the relatively small samples of 54 taxa examined here, it appears that the outer spermoderm cells in most cases are conspicuous and arranged in reticulate pattern with uniform to irregularly thickened boundaries. The variation in seed coat pattern differs from species to species even in infraspecific level.

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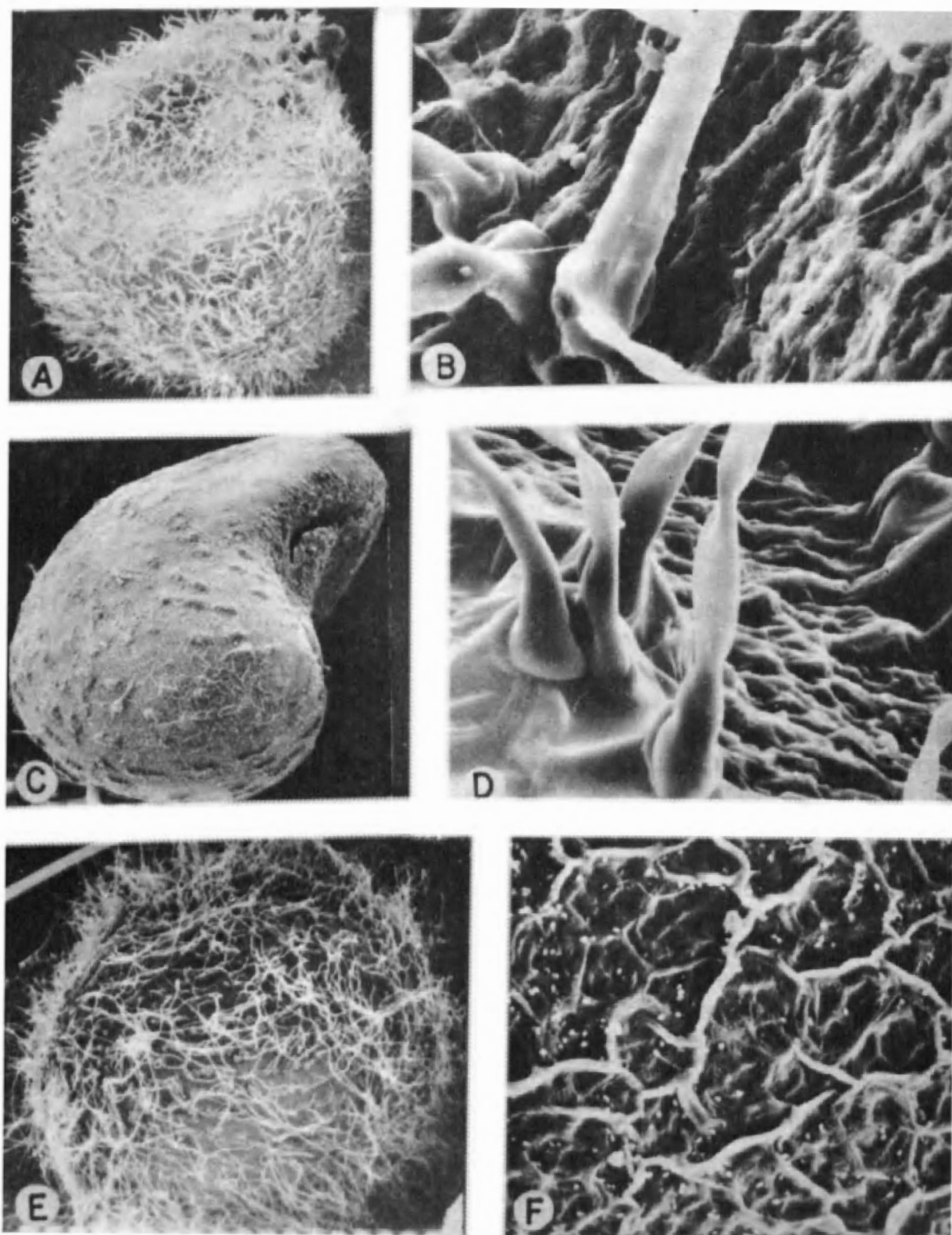


PLATE 1. A—B *Abelmoschus angulosus* : A. Seed $\times 125$. B. Surface $\times 8000$.
 C—D *A. crinitus* : C. Seed $\times 135$. D. Surface $\times 1600$.
 E—F *A. ficulneus* : E. Seed $\times 125$. F. Surface $\times 3600$.

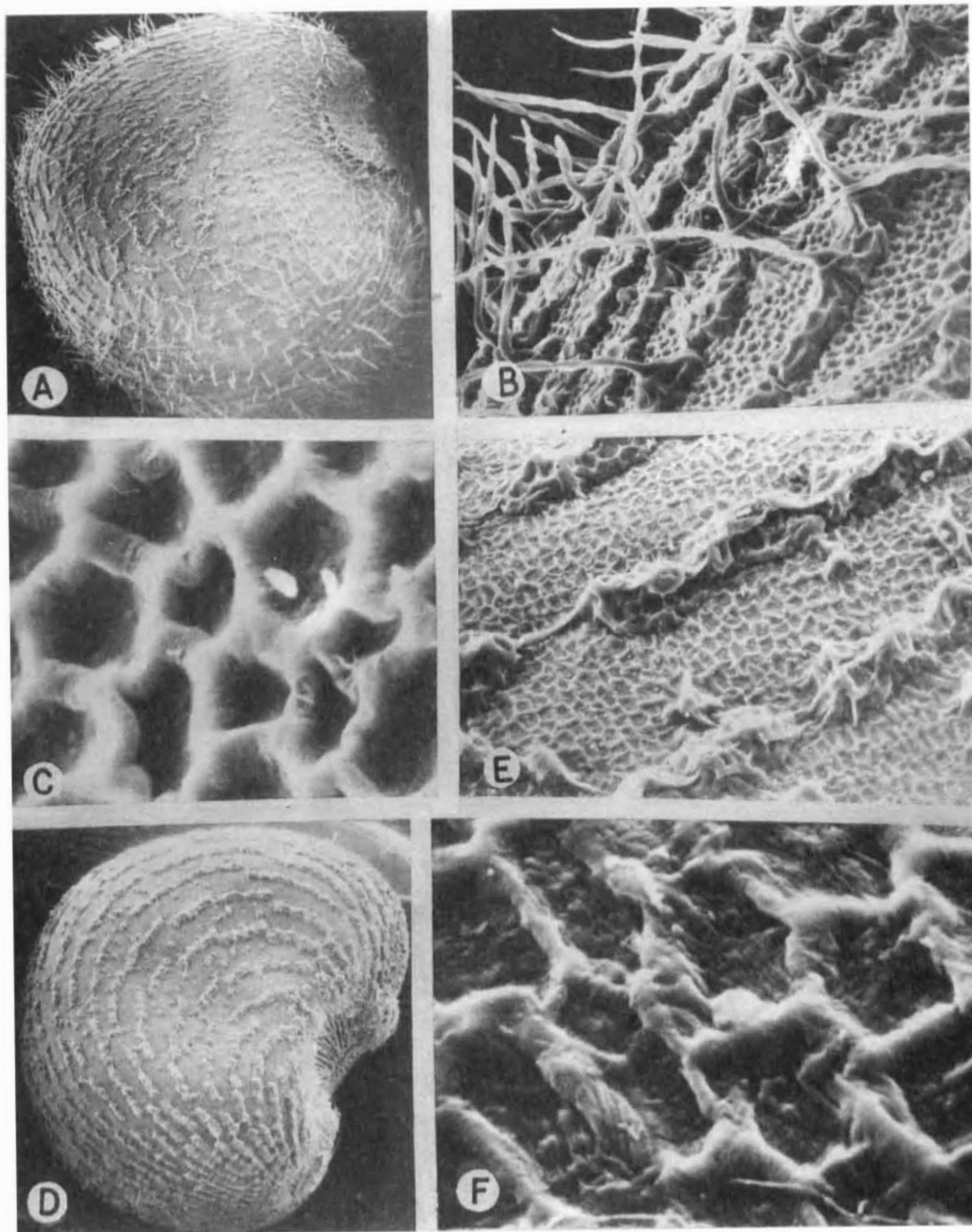


PLATE 2 A—C *Abelmoschus manihot* ssp. *tetraphyllus* A Seed $\times 116$ B Surface $\times 900$ C Surface $\times 7200$.
D—F *A. moschatus* D Seed $\times 125$. E. Surface $\times 950$ F. Surface $\times 7600$

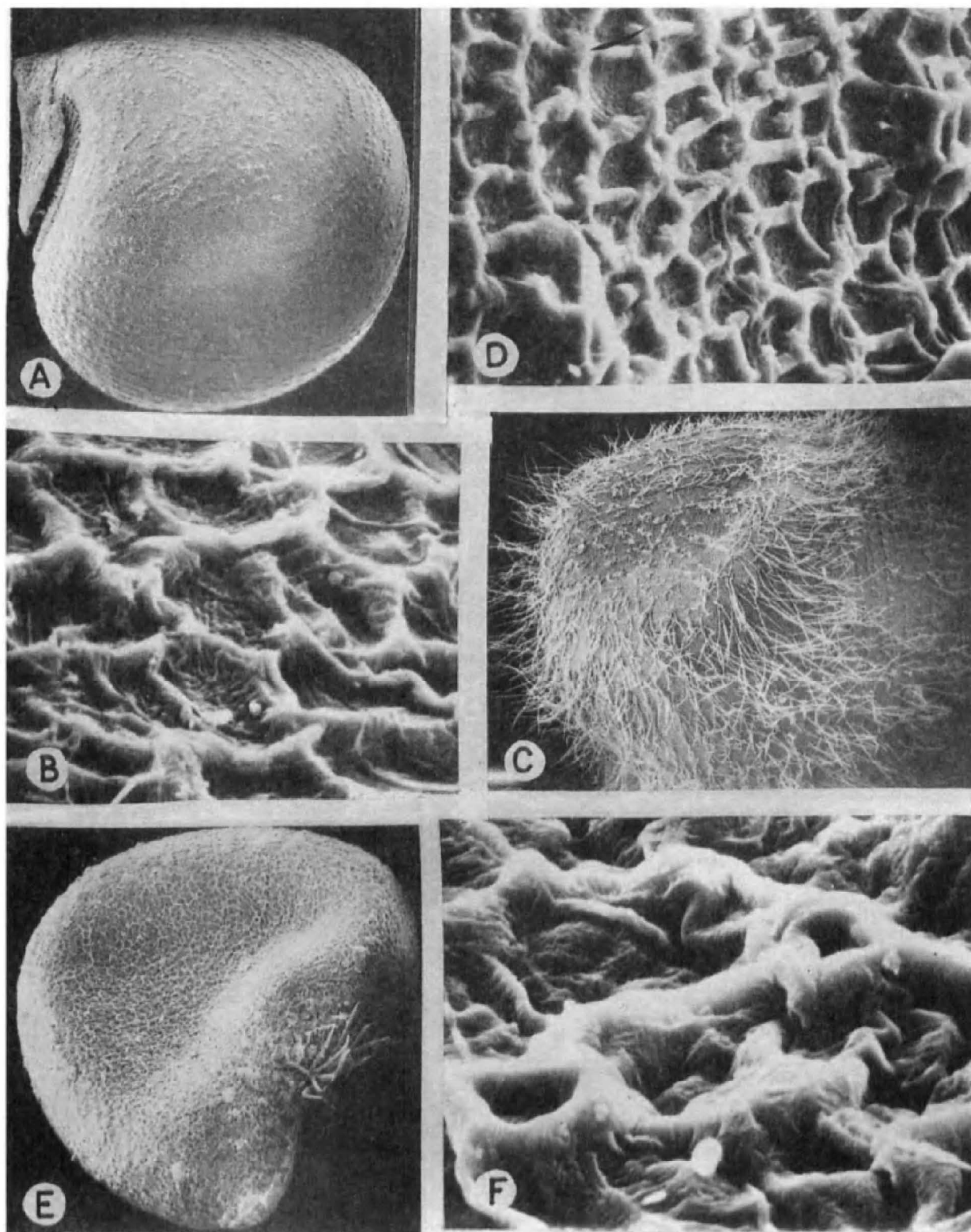


PLATE 3 A—B *Abelmoschus tuberculatus* var. *tuberculatus* A Seed $\times 125$. B Surface $\times 7600$
 C—D *A. tuberculatus* var. *deltoidifolius* C. Seed $\times 130$. D. Surface $\times 3600$.
 E—F *Abutilon bidentatum* E Seed $\times 250$. F. Surface $\times 8000$.

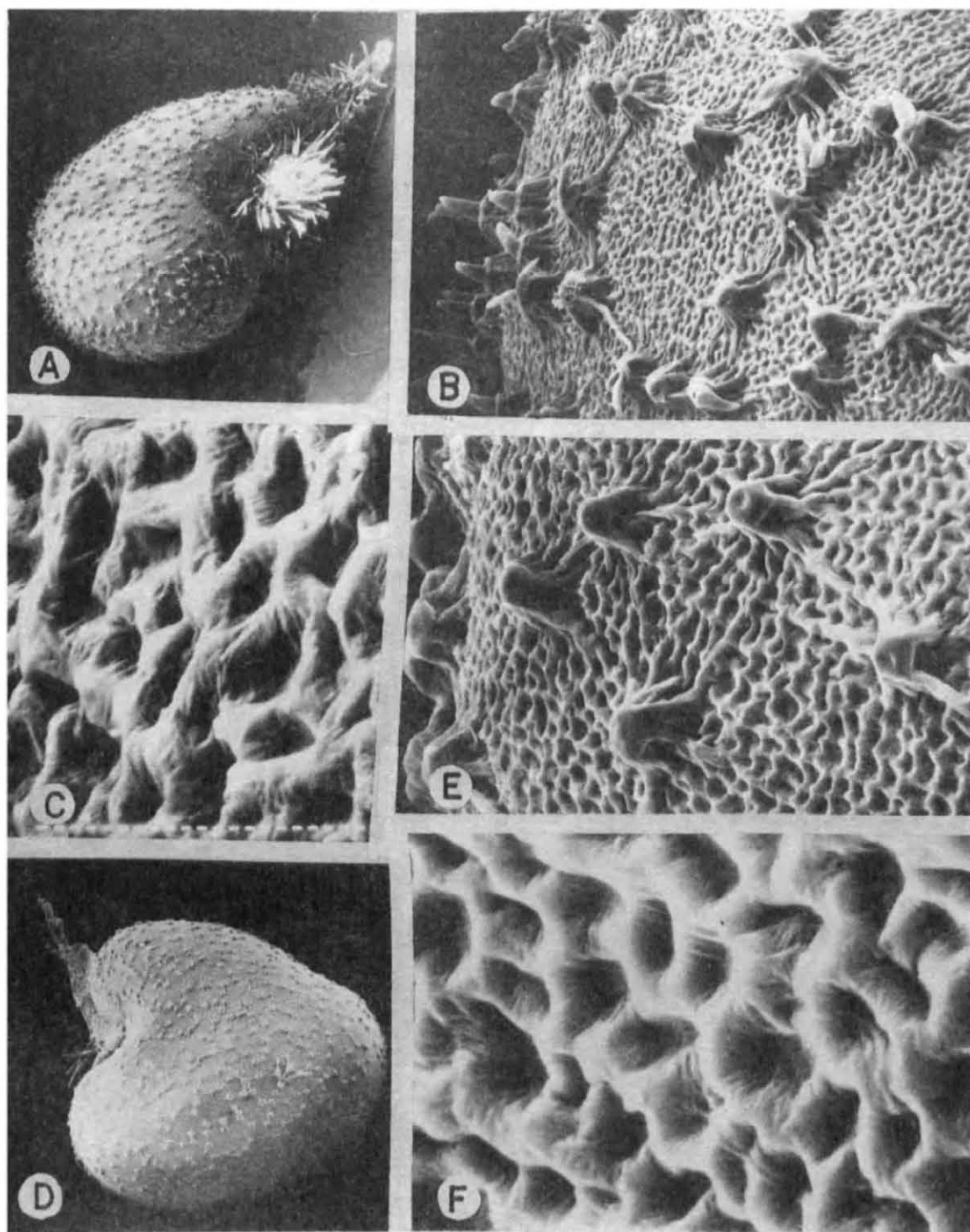


PLATE 4 A—C *Abutilon hirtum* A Seed $\times 135$. B. Surface $\times 1900$. C Surface $\times 8000$
D—F *A. indicum* D Seed $\times 135$. E. Surface $\times 2000$. F. Surface $\times 8000$

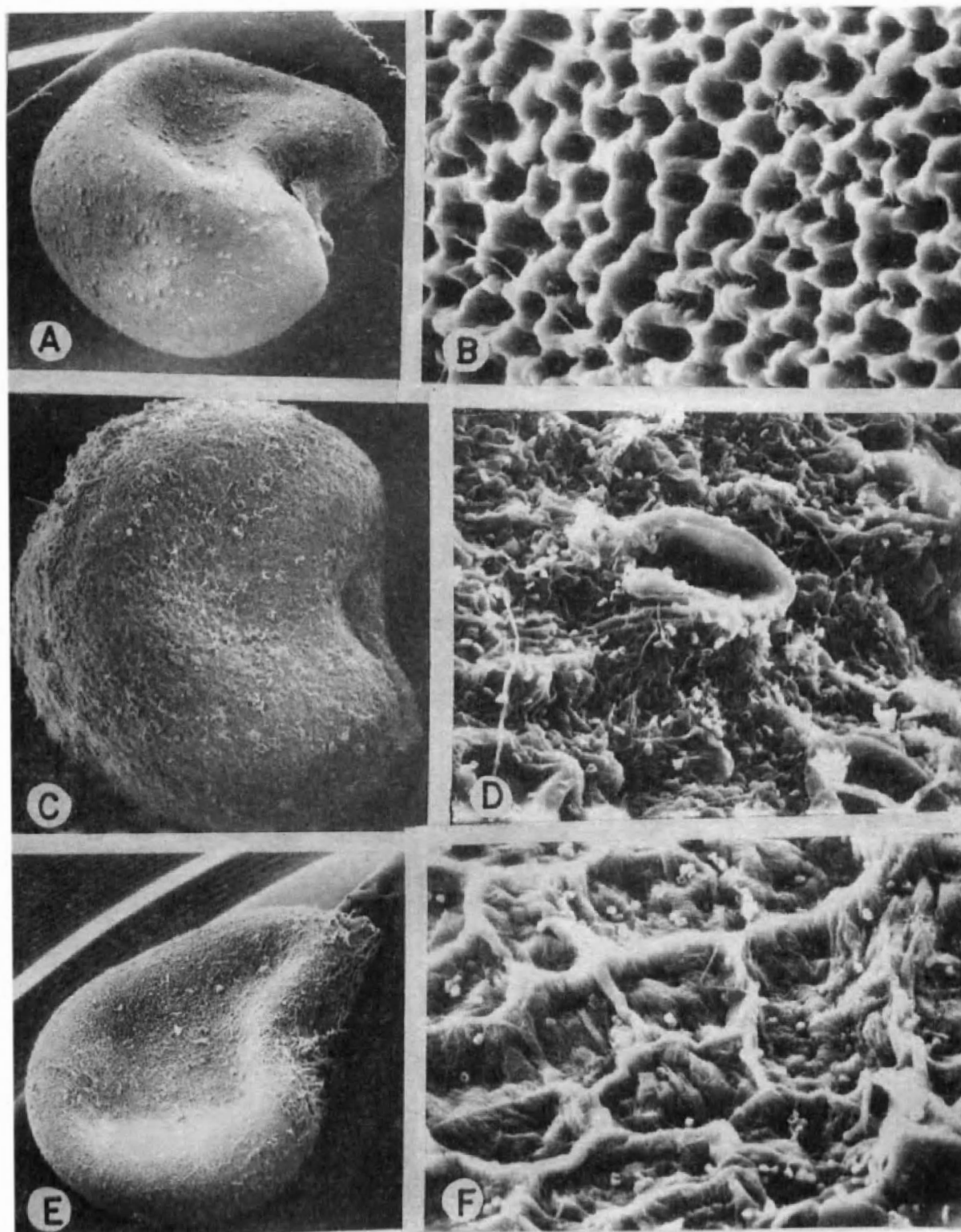


PLATE 5 A—B *Abutilon persicum* A. Seed $\times 125$. B Surface $\times 3800$.
C—D *A. ramosum* C. Seed $\times 235$. D. Surface $\times 3600$.
E—F *A. theophrasti*: E Seed $\times 125$. F. Surface $\times 7600$.

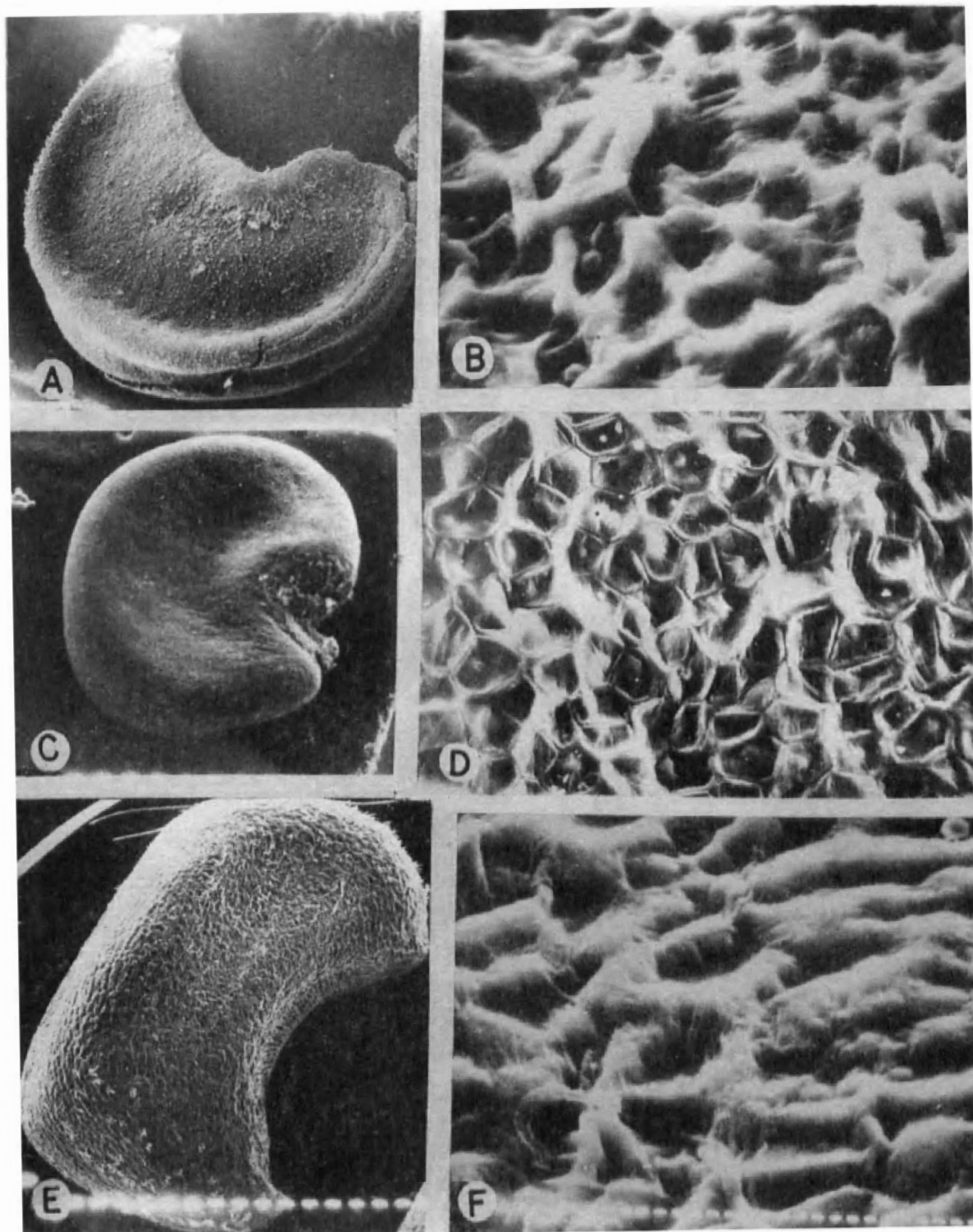


PLATE 6 A—B *Alcea rosea* A. Seed $\times 116$. B. Surface $\times 7600$.
C—D *Decaschistia crotonifolia* C. Seed $\times 100$. D. Surface $\times 1800$.
E—F *Althaea officinalis* E. Seed $\times 135$. F. Surface $\times 7600$.

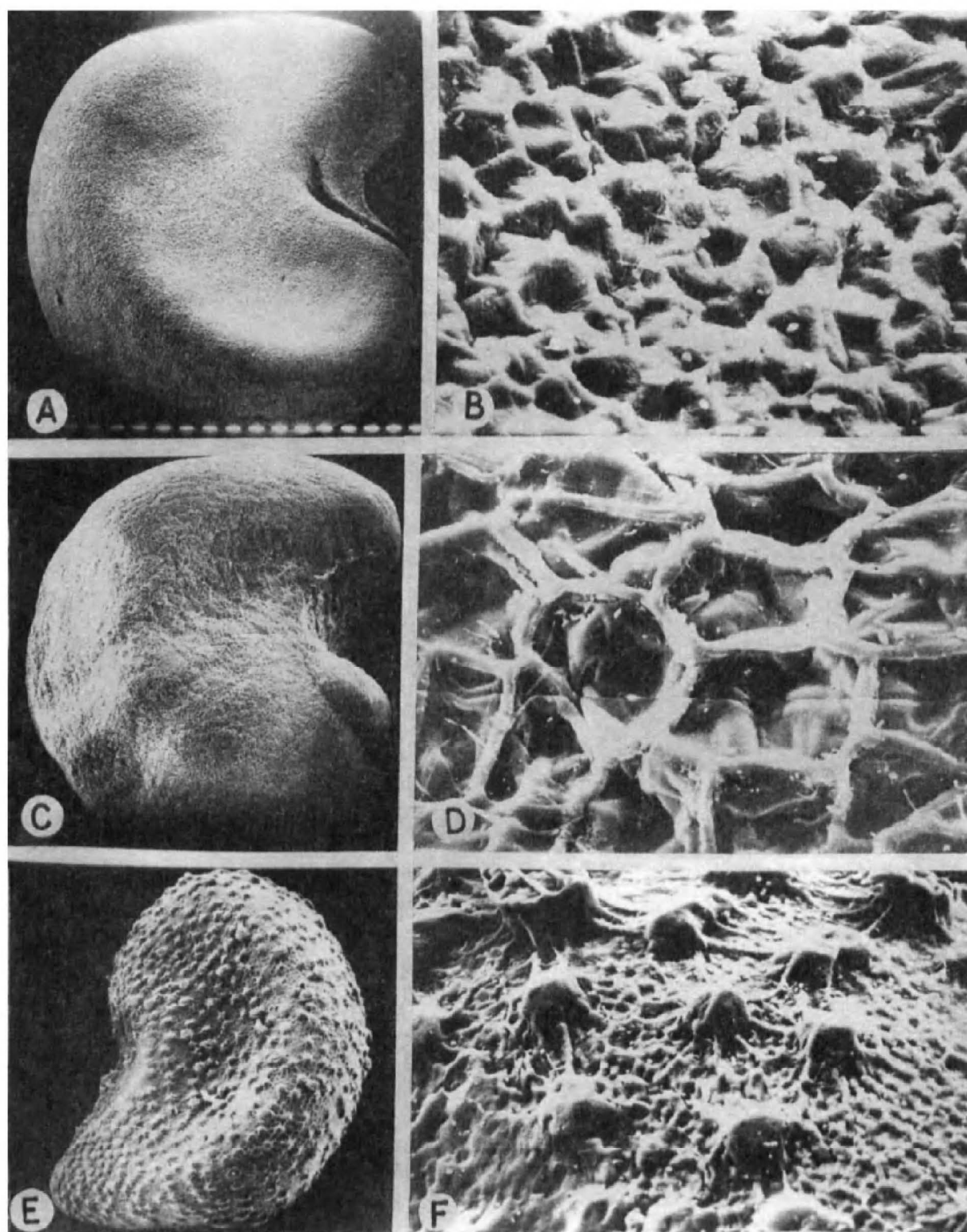


PLATE 7. A—B *Decaschistia trilobata* : A. Seed $\times 115$. B. Surface $\times 4000$
C—D *Dicellostyles jujubifolia* : C. Seed $\times 125$. D. Surface $\times 4000$
E—F *Fioria vitifolia* : E. Seed $\times 137$. F. Surface $\times 1000$.

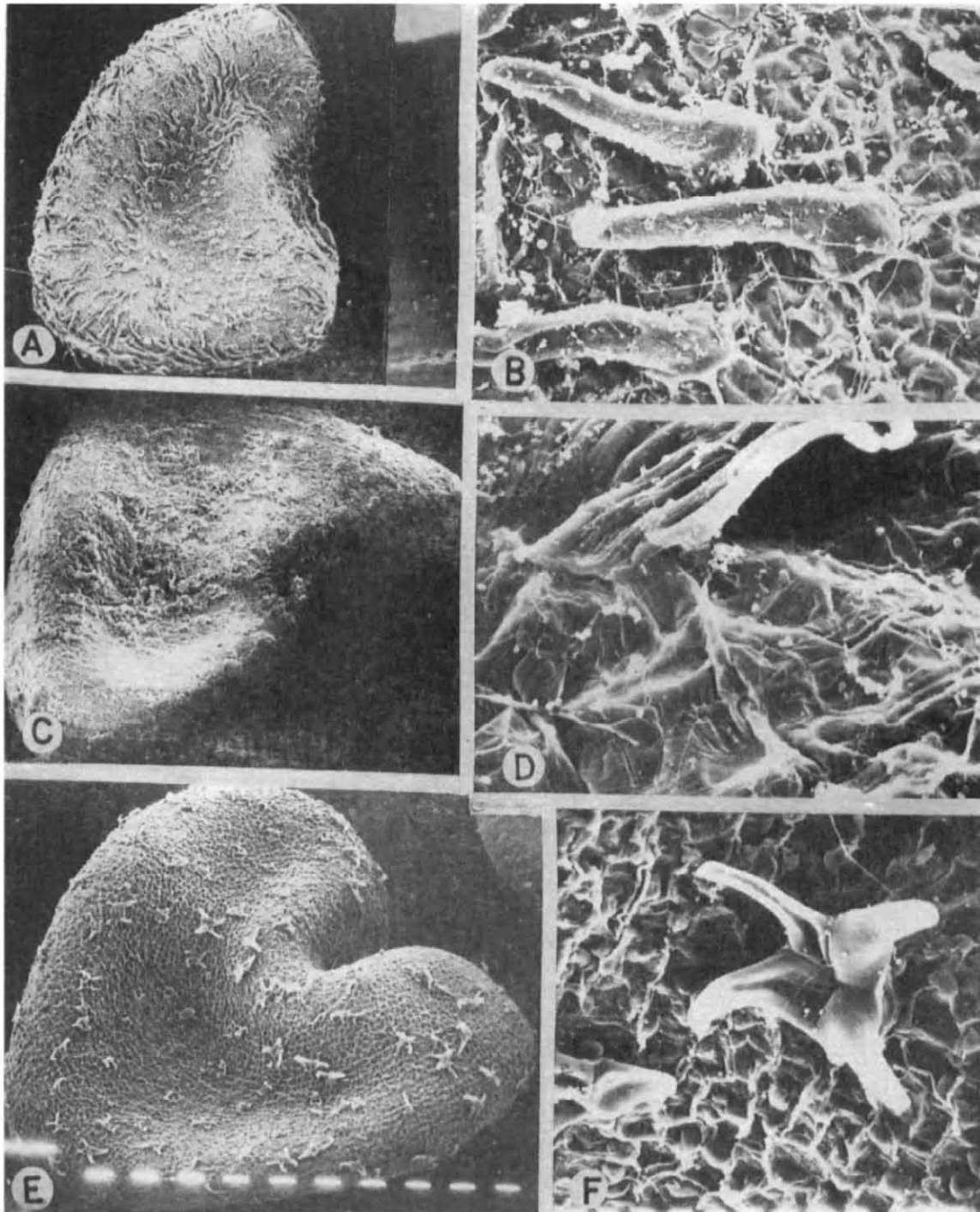


PLATE 8. A—B *Hibiscus caesioides* A. Seed $\times 125$. B. Surface $\times 1800$.
C—D *H. cannabinus* C. Seed $\times 110$, D. Surface $\times 1700$.
E—F *H. lunariifolius* : E. Seed $\times 225$; F. Surface $\times 1600$.

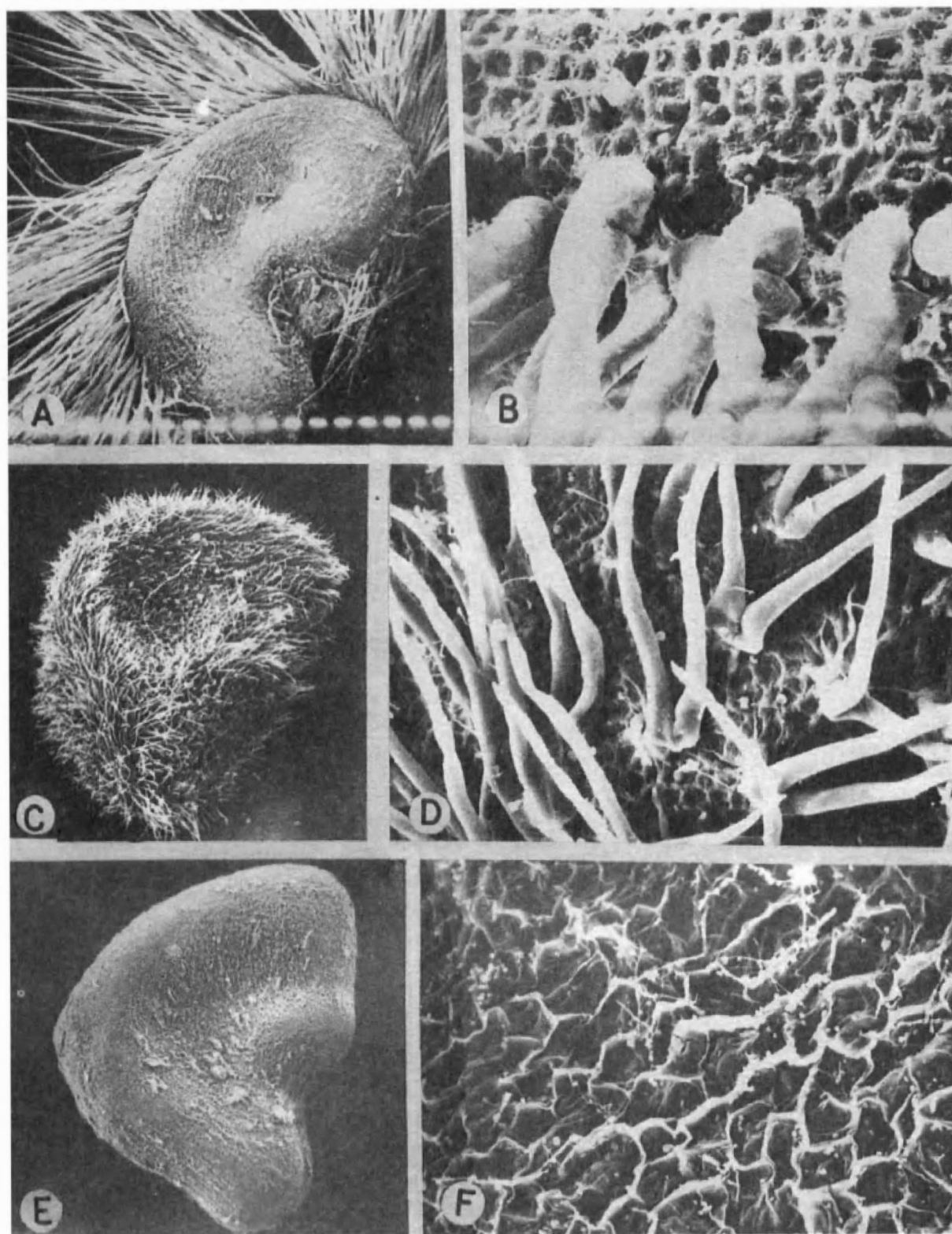


PLATE 9 A—B *Hibiscus macrophyllus* A Seed $\times 100$, B Surface $\times 1800$
 C—D *H. panduraeformis* C. Seed $\times 125$, D. Surface $\times 2000$
 E—F *H. radiatus* E Seed $\times 135$; F. Surface $\times 1900$

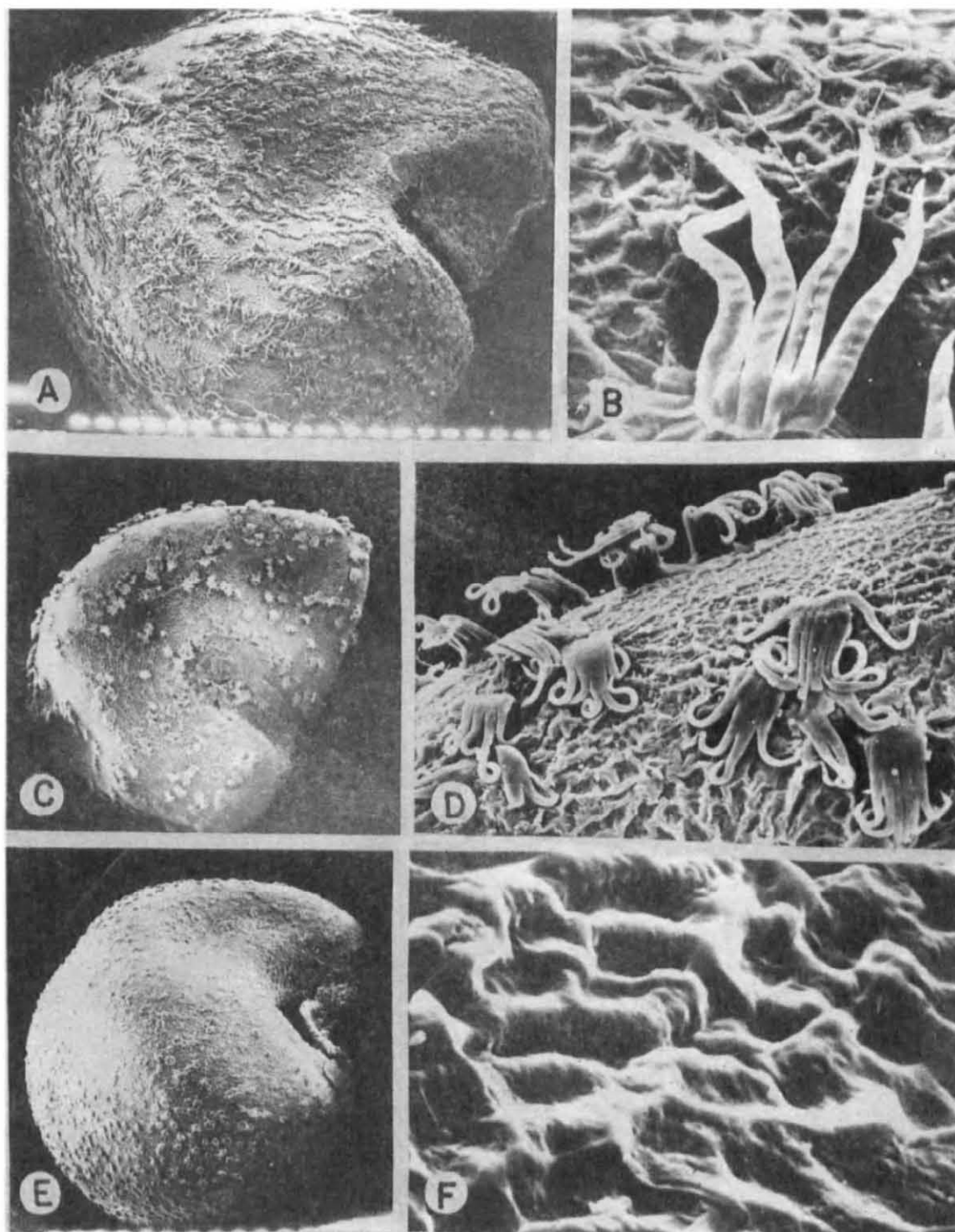


PLATE 10 A—B *Hibiscus sabdariffa* : A. Seed $\times 115$. B. Surface $\times 1400$
C—D *H. surattensis* : C. Seed $\times 150$. D. Surface $\times 950$.
E—F *H. tiliaceus* : E. Seed $\times 125$. F. Surface $\times 8000$.

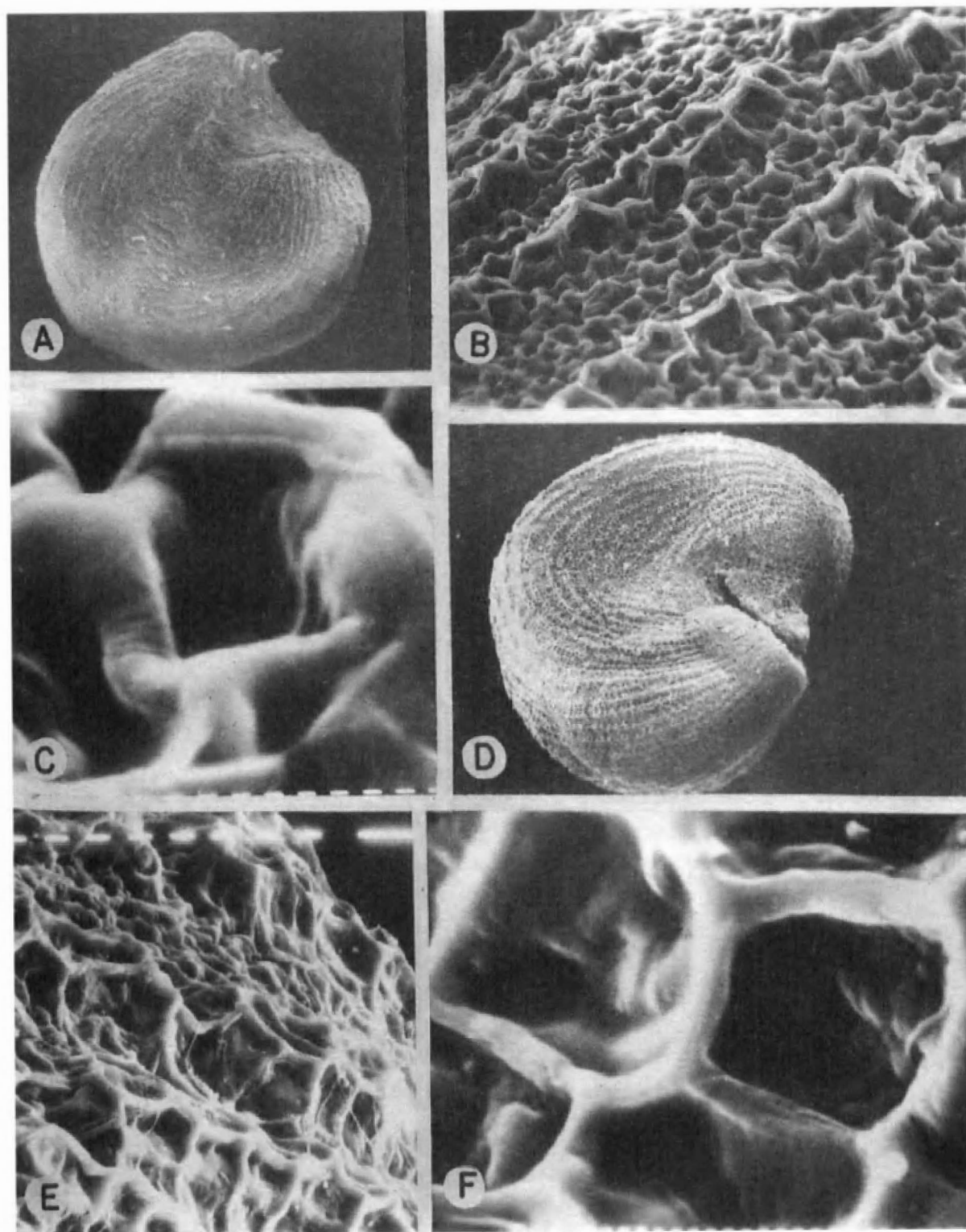


PLATE 11. A—C *Kydia calycina* : A. Seed $\times 150$. B. Surface $\times 1900$ C Surface $\times 19200$
D—F *K. glabrescens* : D. Seed $\times 150$. E. Surface $\times 1500$. F Surface $\times 7600$.

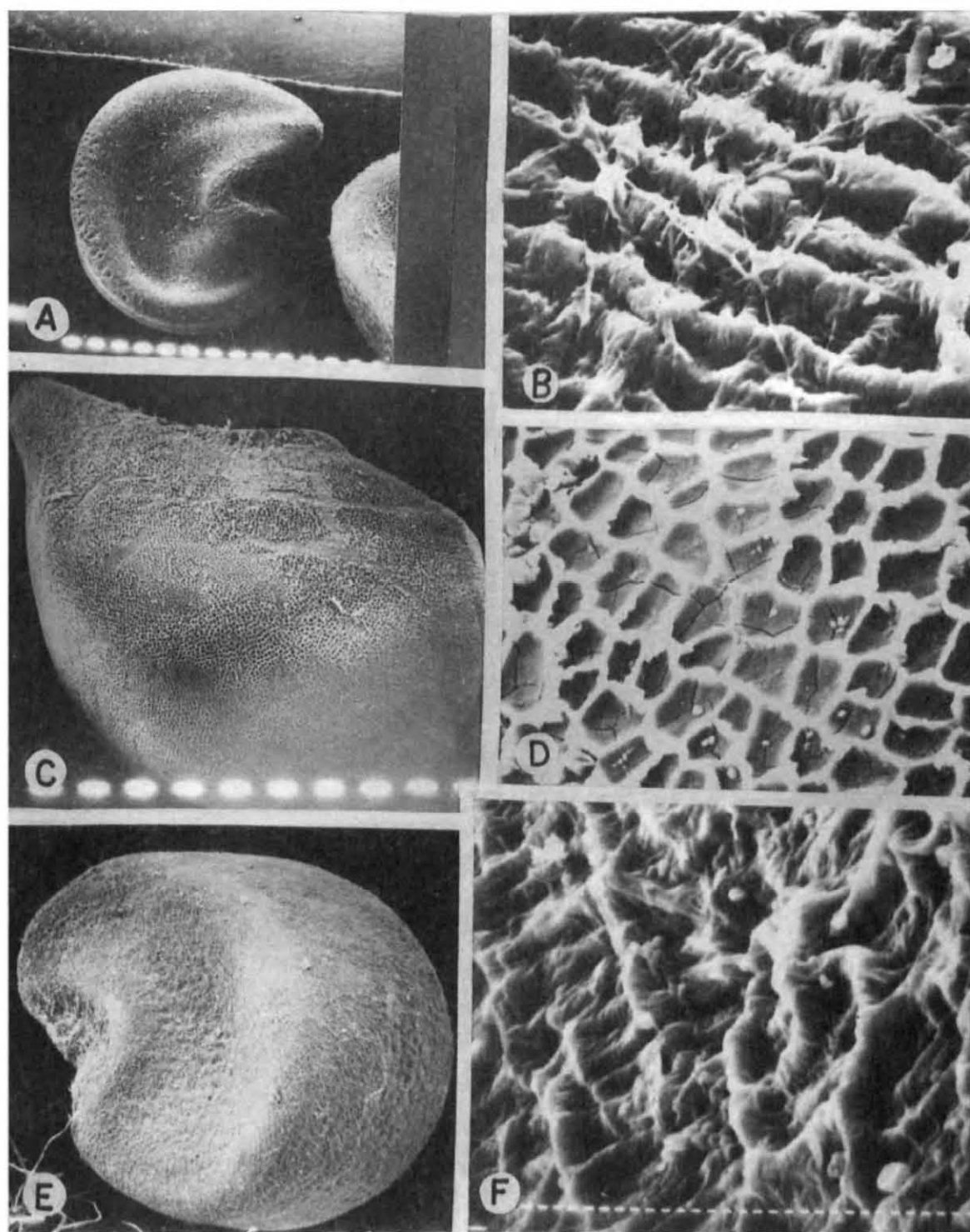


PLATE 12. A—B *Lavatera cachemiriana* A Seed $\times 125$ B Surface $\times 7600$
C—D *Malachra capitata* C. Seed $\times 210$ D. Surface $\times 4200$
E—F *Malva mauritiana* E. Seed $\times 250$ F. Surface $\times 7200$

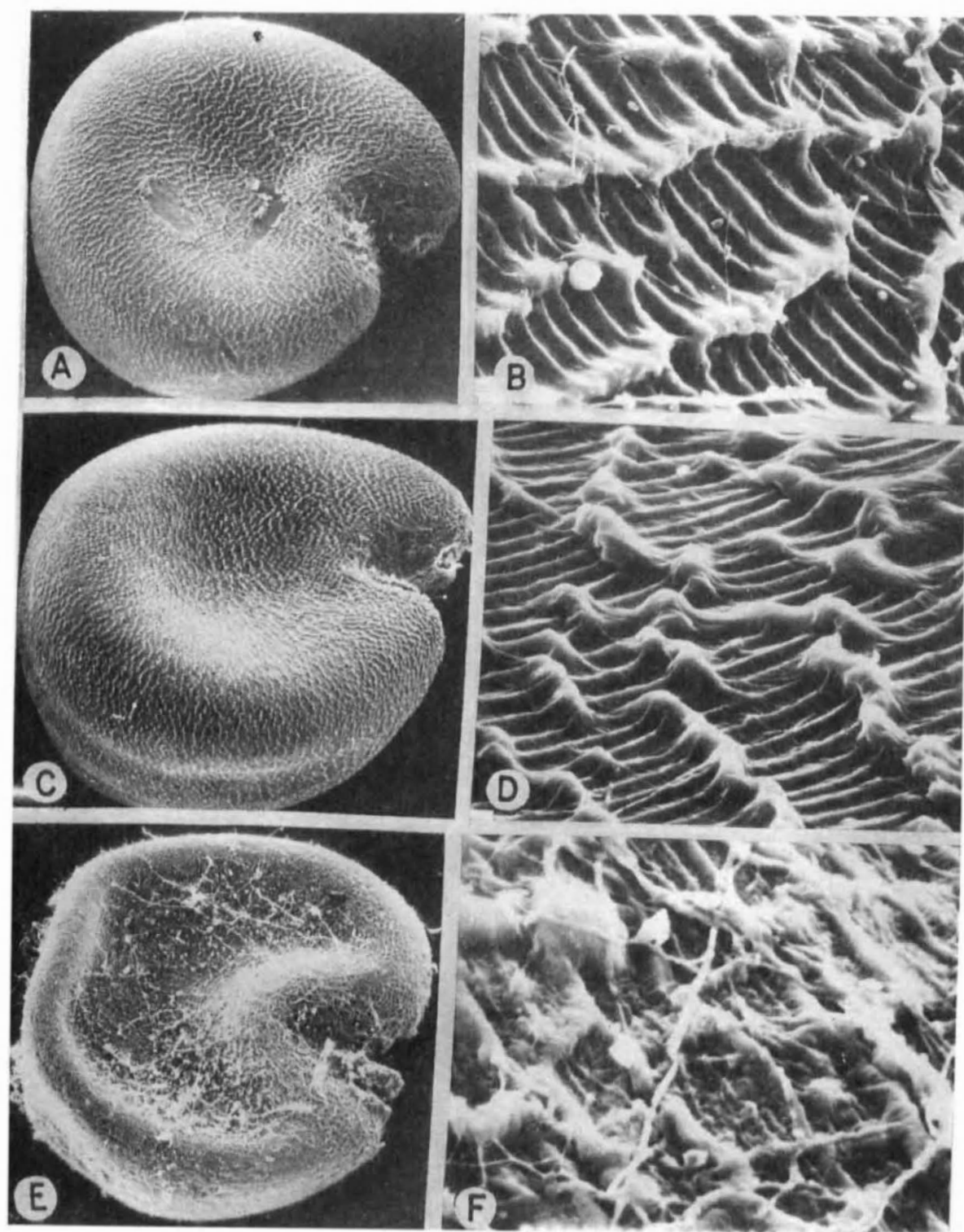


PLATE 13. A—B *Malva neglecta* A. Seed $\times 250$. B. Surface $\times 3600$.
C—D *M. parviflora* C. Seed $\times 235$. D. Surface $\times 7200$.
E—F *M. sylvestris* : E. Seed $\times 235$. F. Surface $\times 7600$.

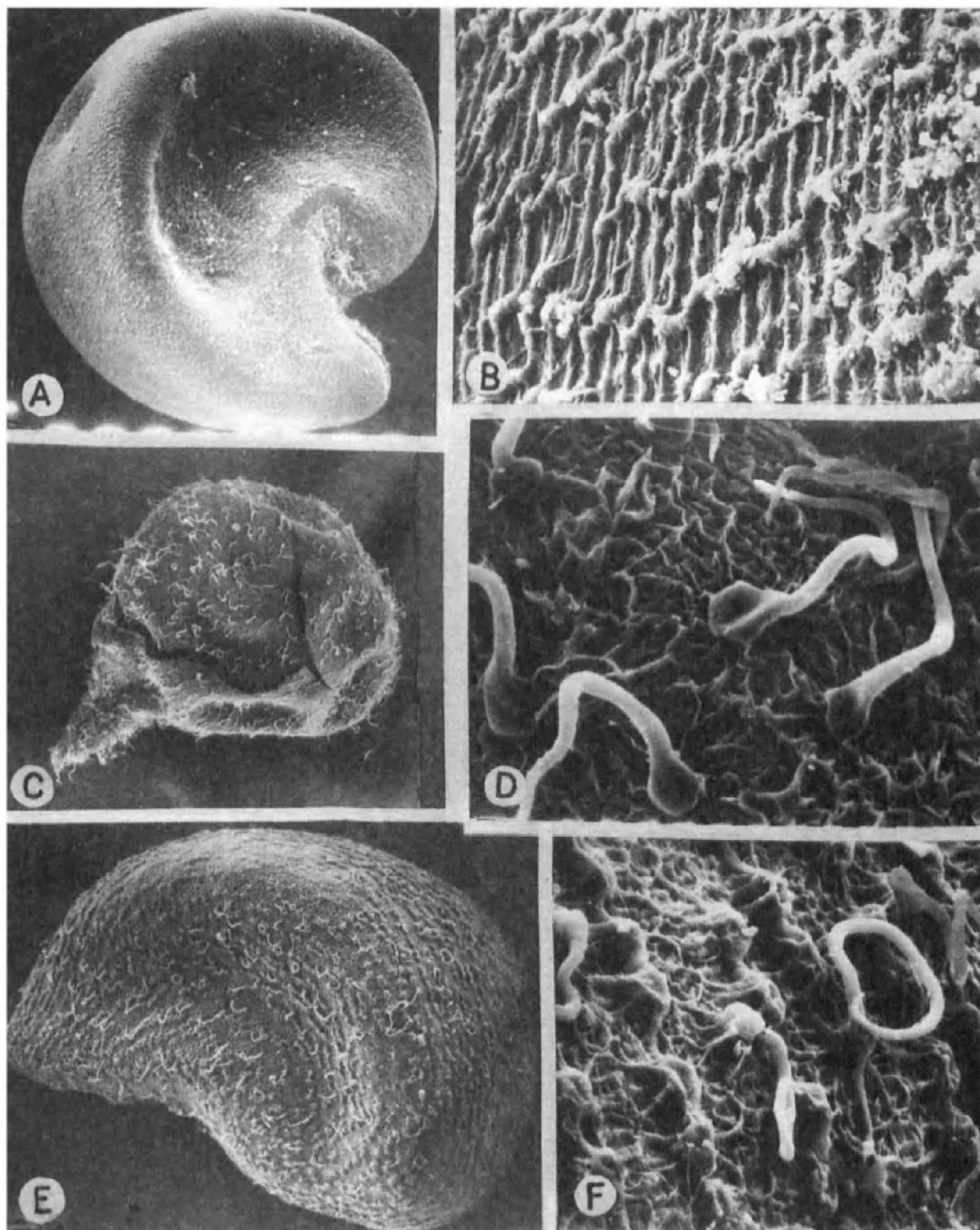


PLATE 14 A—B *Malva verticillata* A Seed $\times 235$. B Surface $\times 3800$
C—D *Pavonia grewoides* C. Seed $\times 150$ D Surface $\times 1800$
E—F *Pavonia odorata* E. Seed $\times 235$. F. Surface $\times 1700$

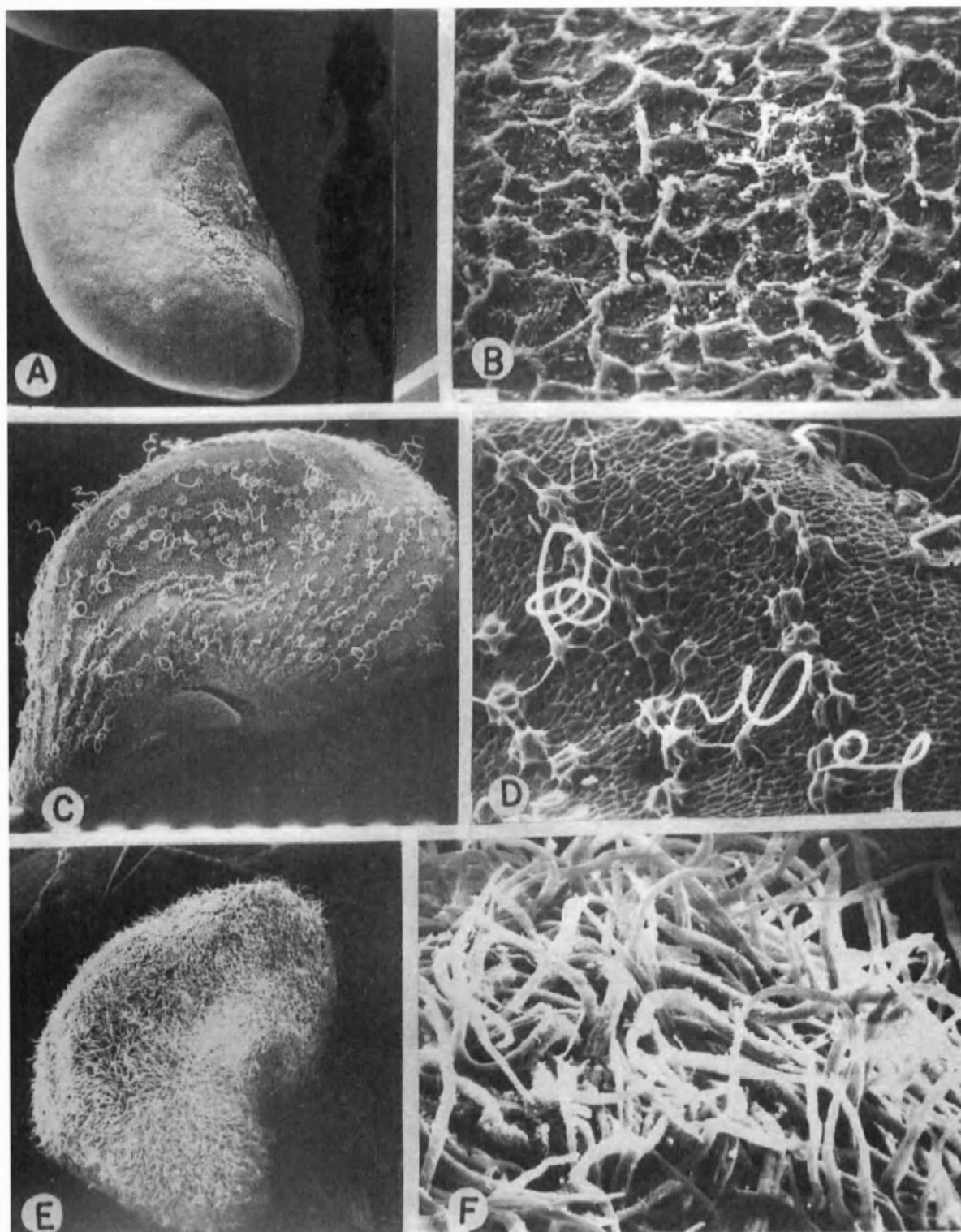


PLATE 15 A—B *Pavonia repanda* · A. Seed $\times 110$. B. Surface $\times 3600$
 C—D *P. zeylanica* · C. Seed $\times 210$. D. Surface $\times 900$
 E—F *Senra incana* · E. Seed $\times 135$. F. Surface $\times 2000$.

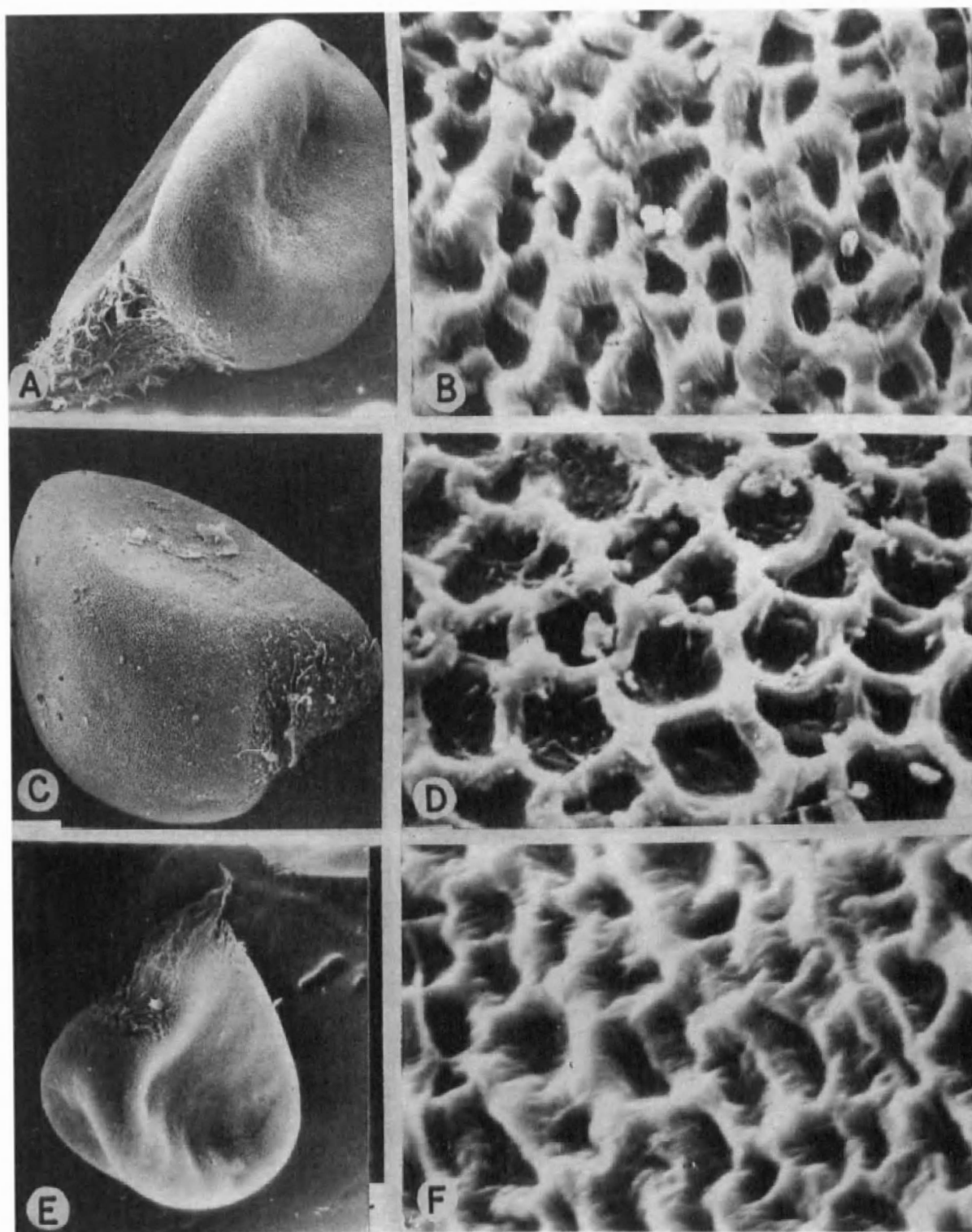


PLATE 16 A—B *Sida acuta* A. Seed $\times 230$. B. Surface $\times 8000$
C—D *S. cordata* C. Seed $\times 215$. D. Surface $\times 8000$
E—F *S. cordifolia* E. Seed $\times 185$. F. Surface $\times 8000$.

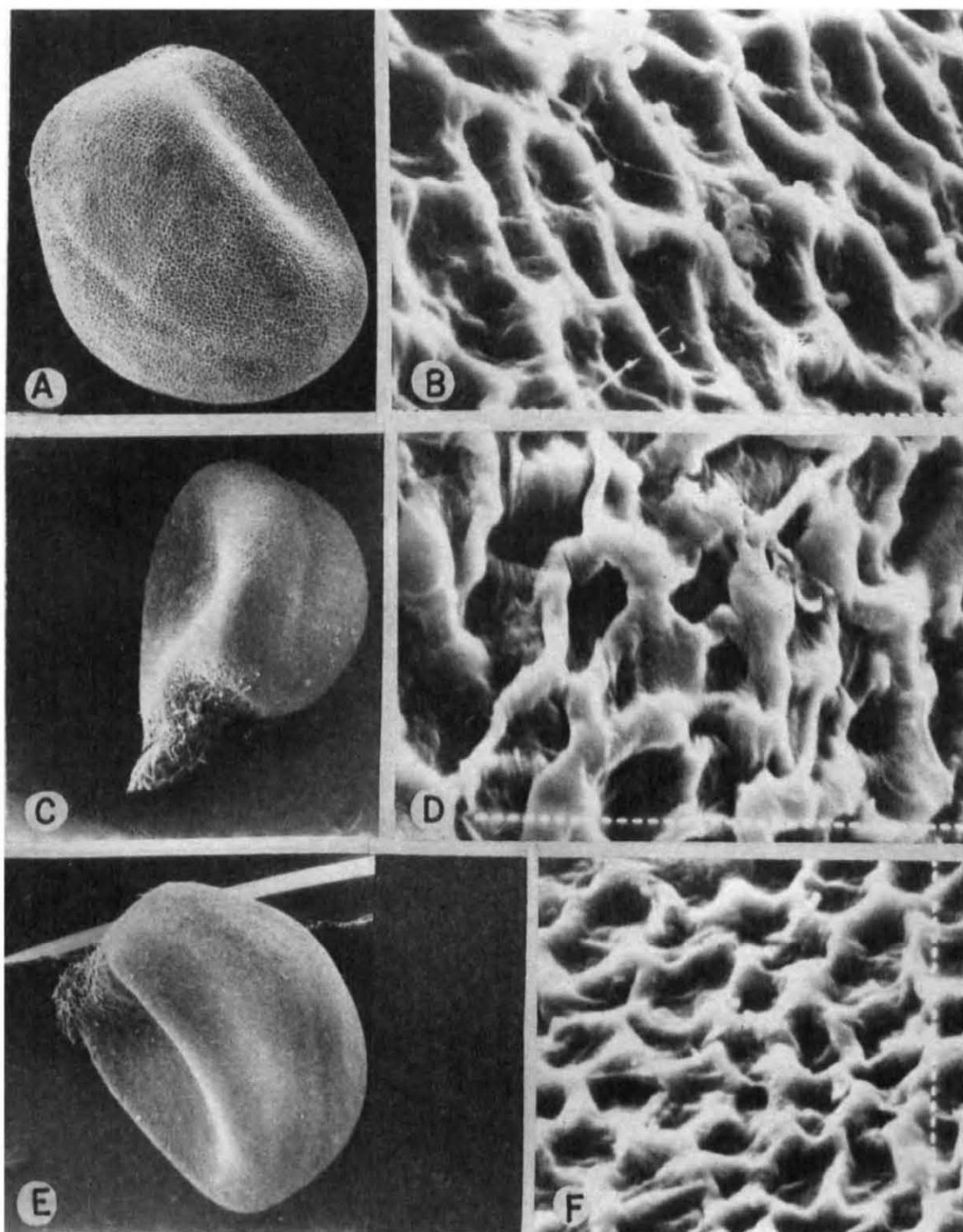


PLATE 17. A—B *Sida mysorensis* A Seed $\times 230$. B. Surface $\times 8000$.

C—D *S. ovata* C. Seed $\times 90$. D Surface $\times 8000$.

E—F *S. rhombifolia* ssp *rhombifolia* var. *rhombifolia* E. Seed $\times 150$. F Surface $\times 8000$

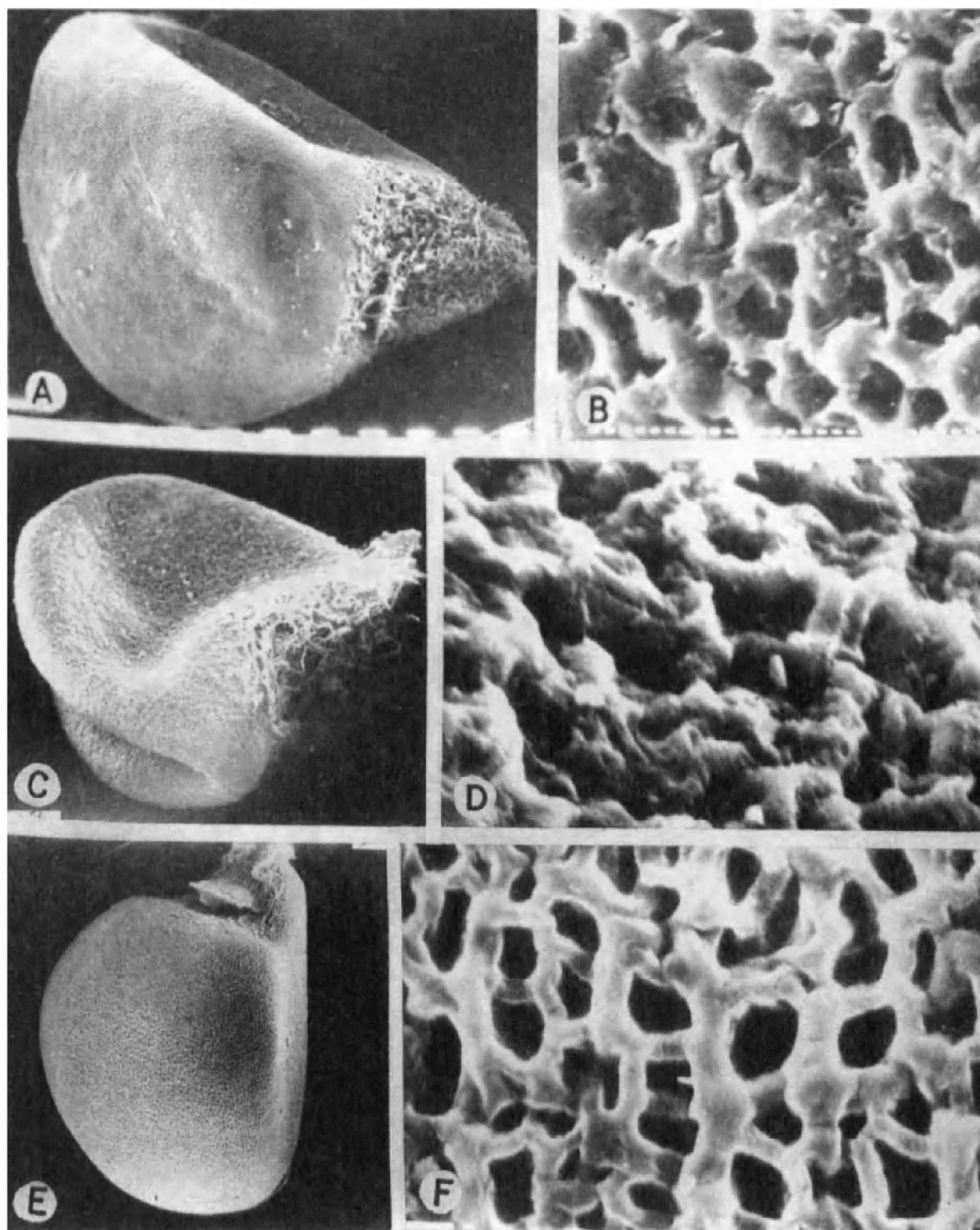


PLATE 18. A—B *Sida rhombifolia* ssp. *retusa* · A Seed $\times 250$. B. Surface $\times 8000$.
C—D *S. rhombifolia* ssp. *rhombifolia* var. *scabrida* · C. Seed $\times 150$. D. Surface $\times 8000$.
E—F *S. spinosa* · E. Seed $\times 225$. F. Surface $\times 8000$.

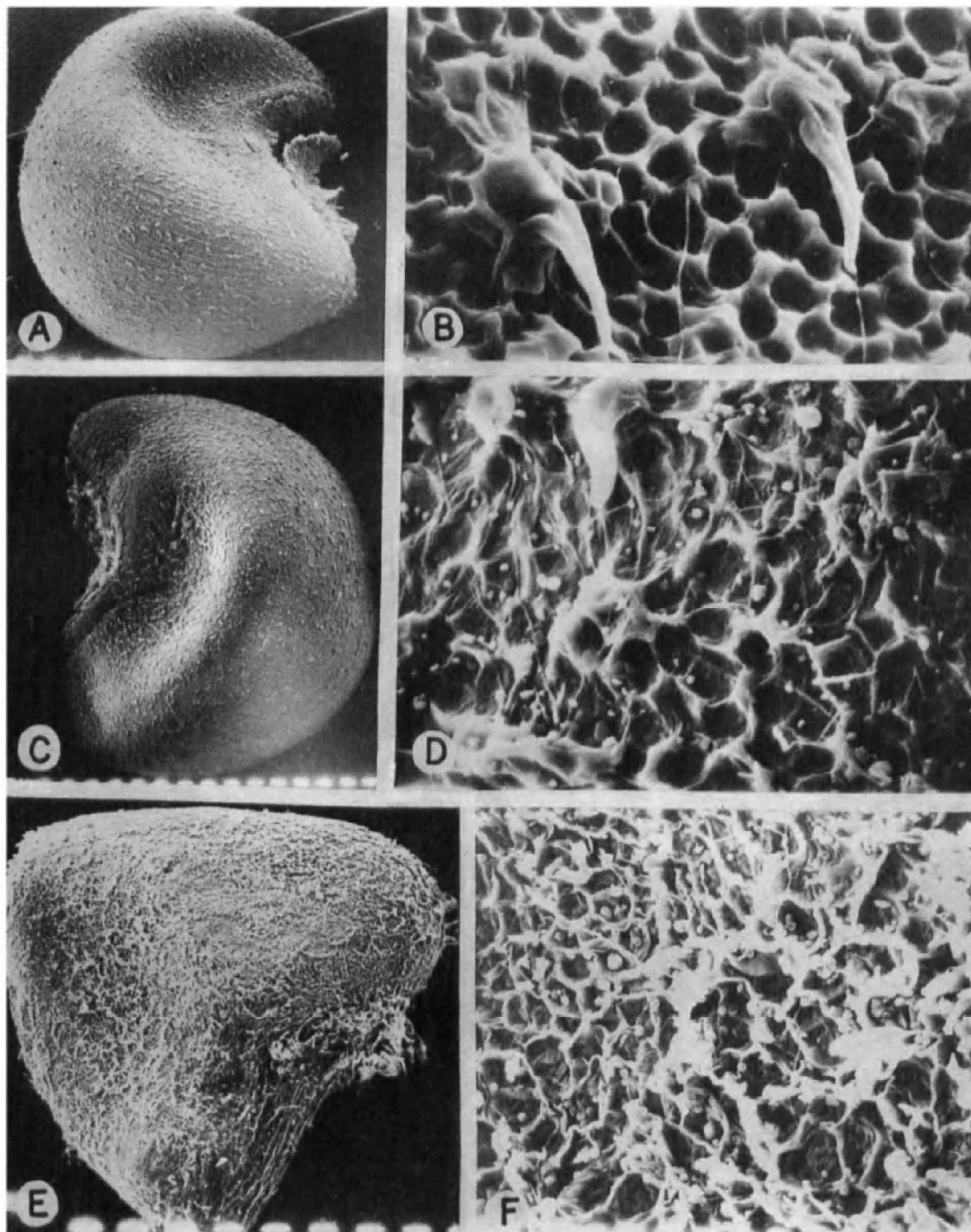


PLATE 19. A—B *Urena lobata* ssp. *lobata* : A. Seed $\times 115$ B. Surface $\times 4000$.
 C—D *U. lobata* ssp. *sinuata* : C. Seed $\times 115$, D. Surface $\times 4000$.
 E—F *Wissadula rostrata* : E. Seed $\times 125$; F. Surface $\times 3600$.