

A Scanning Electron Microscope
Survey of the Epidermis
of East African Grasses, II

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and Alice E. Tucker*



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ABSTRACT

Palmer, Patricia G., and Alice E. Tucker. A Scanning Electron Microscope Survey of the Epidermis of East African Grasses, II. *Smithsonian Contributions to Botany*, number 53, 72 pages, 52 plates, 1983.—In developing a reference collection as a standard for using fossil grass cuticles as a paleoecological tool, we have examined leaf epidermal features of grasses with SEM. Descriptions are presented of the abaxial and adaxial surfaces of the leaves of 26 East African species, comprising nine tribes of the subfamily Pooideae—Poeae, Bromeae, Brachypodieae, Triticeae, Meliceae, Aveneae, Phalarideae, Agrostideae, Stipeae.

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A Scanning Electron Microscope Survey of the Epidermis of East African Grasses, II

Patricia G. Palmer and Alice E. Tucker

Introduction

By comparing the anatomical features of fossil grass leaves from East African lake sediments with those of modern-day grasses, it is often possible to identify fossil leaf fragments to the genus (Palmer, 1976). Because of the importance of fossil grasses as paleoecological indicators in tropical Africa, it has been necessary to develop a reference collection of modern grasses as a standard for comparison. For our purposes we have found that examination of the grass leaves with scanning electron microscopy (SEM) is preferable to light microscopy. In an earlier paper, we discussed our system of describing the diagnostic features of grass leaves as viewed with SEM and gave descriptions of 24 East African species representing ten tribes (Palmer and Tucker, 1981). The reader is referred to this earlier paper for discussion of terminology and illustrations of diagnostic features.

This paper represents the second part of a survey of East African grasses and includes 26 genera representing nine tribes of the Pooideae: Poeae, Bromaeae, Brachypodieae, Triticeae, Meliceae, Aveneae, Phalarideae, Agrostideae, Stipeae. We delimit East Africa to include Uganda,

Kenya and Tanzania, the region dealt with in the *Flora of Tropical East Africa, Gramineae* by Clayton (1970, 1974, in prep.). We also follow the nomenclature of the *Flora of Tropical East Africa*.

Hartley (1973) has shown that the pooid grasses are found in temperate regions of the world and in the tropics are limited to high altitudes. A recent study by Livingstone and Clayton (1980) indicates that temperature is the most likely environmental factor controlling the importance of pooid genera in the highlands of tropical Africa. Because the occurrence of pooid genera in the fossil record of East Africa will permit paleotemperature estimates (Livingstone and Clayton, 1980), the early inclusion of the tribes treated in this paper is extremely important in our overall survey.

MATERIALS AND METHODS.—Leaf material for scanning electron microscopy was taken from dried herbarium material. A section from the middle portion of a blade from an upper, mature, undamaged leaf was chosen for study. In a few cases, where the epidermis proved to have a heavy coat of epicuticular wax, the wax was removed by soaking in xylene for 12 to 14 hours. Two pieces of the leaf (one exposing the abaxial or lower surface, the other exposing the adaxial or upper surface) were mounted on stubs with double-coated Scotch tape. The specimens were sputter-coated with gold-palladium, observed with a

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JEOL T20 or a Philips 501 scanning electron microscope and photographed, using Polaroid P/N 665 or P/N 55 film. Occasionally, specimens were examined by energy dispersive X-ray analysis using the EDAX 9100/60 to clarify certain anatomical features. The photomicrographs are deposited in the laboratory of D.A. Livingstone, Department of Zoology, Duke University.

Each specimen was analyzed at the microscope using a standard check sheet of diagnostic features. By comparing the photomicrographs and the check sheets, a complete description of each taxon was compiled. At least one species of each genus was examined, and for some large genera several species were examined to determine intrageneric variability. In some cases more than one specimen of a species was examined to determine intraspecific variability.

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Format for Species Descriptions

STOMATA.—Frequency; subsidiary cell shape; distribution; special features.

INTERSTOMATAL CELLS.—Shape; end walls; outline of walls. *Papillae*: Number/cell, distribution on each cell, shape, size.

LONG CELLS.—Shape; outline of walls. *Papillae*: Number/cell, distribution on each cell, shape, size.

PRICKLES.—Frequency; location and type.

SHORT CELLS.—Location and distribution. *Silica Cells*: Location and frequency. *Cork Cells*: Location and frequency.

SILICA BODIES.—Location and shape.

MICROHAIRS.—Frequency; number of cells; shape; shape of apex.

MACROHAIRS.—Frequency; location; nature of base.

SPECIAL FEATURES.—Description of unique features not covered in other categories.

Tribe POEAE

Briza maxima Linnaeus

PLATES 1-2

ABAXIAL

STOMATA.—Common; parallel; 2 stomatal bands/intercostal zone, 2 rows/band. Shape of subsidiary cell often unclear because of collapsed cells; veins not obvious (Plate 1*b*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform to nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 1*c*).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen (Plate 1*a,d,e*).

PRICKLES.—None seen.

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal infrequent; intercostal not seen (Plate 1*f*).

SILICA BODIES.—Costal elongated-smooth, elongated-sinuous; intercostal not seen (Plate 1*f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common; parallel; 2 stomatal bands/intercostal zone, 2 rows/band (Plate 2*a,b*).

INTERSTOMATAL CELLS.—Rectangular to long,

narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 2c).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen (Plate 2d,e).

PRICKLES.—Infrequent; small costal prickles (Plate 2f).

SHORT CELLS.—None seen.

SILICA BODIES.—None seen.

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Colpodium chionogeiton (Pilger) Tzvelev

PLATES 3-4

ABAXIAL

STOMATA.—Abundant; parallel to sometimes low-dome; 4-6 stomatal bands/intercostal zone, 1 or 2 rows/band (Plate 3a,b).

INTERSTOMATAL CELLS.—Rectangular to square; ends slightly concave; nonsinuous. *Papillae*: 1/cell, globose, uniform. Appear to be thin-walled because usually deflated (Plate 3a,b,c).

LONG CELLS.—Rectangular to long, narrow, width nonuniform; nonsinuous. *Papillae*: 1/cell, globose, uniform (Plate 3a,c).

PRICKLES.—Abundant; costal short, papillate-type (Plate 3d).

SHORT CELLS.—Costal solitary, paired; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal common; intercostal not seen (Plate 3e,f).

SILICA BODIES.—Costal oblong, square; intercostal not seen (Plate 3e,f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Abundant; parallel; 4 stomatal bands/intercostal zone, 1 row/band. Bands difficult to detect because of collapsed long cells. Costal regions often indistinct (Plate 4a,b).

INTERSTOMATAL CELLS.—Rectangular; ends slightly concave or sometimes straight to convex;

nonsinuous. *Papillae*: 1/cell, globose, uniform. Often deflated, probably thin-walled (Plate 4a,c).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: 1/cell, globose, uniform. Often deflated, probably thin-walled (Plate 4a,c).

PRICKLES.—Abundant on margin, absent elsewhere; short unpointed with swollen bases. Several rows of cells near margin have large papillate-type prickles (Plate 4f).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 4d).

SILICA BODIES.—Costal oblong, elongated-smooth, square; intercostal not seen (Plate 4d,e).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Dactylis glomerata Linnaeus

PLATES 5-6

ABAXIAL

STOMATA.—Common; parallel; 2 or 3 stomatal bands/intercostal zone, 2 rows/band (Plate 5a,b).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 5c).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen (Plate 5a,d).

PRICKLES.—Common to abundant; costal prickles. Size variable (Plate 5d,e).

SHORT CELLS.—Costal 3-5/row; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal common; intercostal not seen. Short cells indistinct because of wax (Plate 5e,f).

SILICA BODIES.—Costal oblong, elongated-smooth, elongated-sinuous; intercostal not seen (Plate 5e,f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Infrequent to common; parallel; 2 stomatal bands/intercostal zone, 1–3 rows/band. Cells collapsed and shape difficult to ascertain (Plate 6*b*).

INTERSTOMATAL CELLS.—Long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 6*c*).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen (Plate 6*a,c*).

PRICKLES.—Common; costal prickles. Size variable (Plate 6*c,d*).

SHORT CELLS.—Costal 3–5/row; intercostal not seen. *Silica Cells*: Costal infrequent to common; intercostal not seen. *Cork Cells*: Costal infrequent to common; intercostal not seen. Cells often obscured by wax (Plate 6*e,f*).

SILICA BODIES.—Costal elongated-sinuous, nodular; intercostal not seen (Plate 6*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Festuca abyssinica* A. Richard**

PLATES 7–8

ABAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking raised. *Papillae*: None seen (Plate 7*a,c*).

PRICKLES.—Infrequent to common; costal and intercostal prickles (Plate 7*b,c*).

SHORT CELLS.—Costal and intercostal paired. *Silica Cells*: Costal and intercostal abundant. *Cork Cells*: Costal and intercostal abundant. Covered by reticulated wax (Plate 7*c,e,f*).

SILICA BODIES.—Costal and intercostal elliptical or sometimes round, crescent-shaped (Plate 7*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common; parallel; 1–2 stomatal bands/intercostal zone, 2 or 3 rows/band. Stomata sunken among inflated long cells and obscured by long cells (Plate 8*b*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen. Cells raised, appear inflated (Plate 8*b*).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen. Cells raised, appear inflated. Difficult to distinguish between costal and intercostal region (Plate 8*a,c,e*).

PRICKLES.—Common; intercostal prickles. Prickles long; approaching short, macrohair type in length (Plate 8*d,e*).

SHORT CELLS.—Costal not seen; intercostal solitary. *Silica Cells*: Costal not seen; intercostal infrequent. *Cork Cells*: Costal and intercostal not seen (Plate 8*f*).

SILICA BODIES.—Costal not seen; intercostal square to oblong (Plate 8*f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Lolium temulentum* Linnaeus**

PLATES 9–10

ABAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. Occasionally, marginal cells have indistinctly sinuous outlines. *Papillae*: None seen (Plate 9*a*).

PRICKLES.—Infrequent; costal prickles. Primarily in marginal areas (Plate 9*b,c*).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal and intercostal not seen. Silica cells found only in marginal areas and on mid-vein (Plate 9*d–f*).

SILICA BODIES.—Costal elongated-sinuous, round; intercostal not seen (Plate 9*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Abundant; parallel; 2 stomatal bands/intercostal zone, 4 rows/band (Plate 10*b,c*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform; ends straight to convex; nonsinuuous. *Papillae*: None seen (Plate 10*c*).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuuous. *Papillae*: None seen (Plate 10*a,c*).

PRICKLES.—Abundant; costal and occasionally intercostal prickles (Plate 10*d,e*).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 10*f*).

SILICA BODIES.—Costal elongated-smooth, elongated-sinuuous; intercostal not seen (Plate 10*f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Poa schimperana* A. Richard**

PLATES 11–12

ABAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuuous. *Papillae*: None seen (Plate 11*a–c*).

PRICKLES.—Infrequent; costal prickles (Plate 11*d*).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 11*e,f*).

SILICA BODIES.—Costal elongated-sinuuous; intercostal not seen. Occasionally very long (Plate 11*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Abundant; parallel; 2 stomatal bands/intercostal zone, 2 rows/band (Plate 12*a–c*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuuous. *Papillae*: None seen (Plate 12*c*).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuuous. *Papillae*: None seen (Plate 12*a,c*).

PRICKLES.—Common; costal and occasionally intercostal prickles (Plate 12*d,e*).

SHORT CELLS.—Costal solitary or sometimes paired; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 12*f*).

SILICA BODIES.—Costal elongated-sinuuous; intercostal not seen (Plate 12*f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Pseudobromus sylvaticus* Schumann**

PLATES 13–14

ABAXIAL

STOMATA.—Infrequent; parallel to occasionally low-dome; 2 stomatal bands/intercostal zone, 1 row/band. Distribution difficult to determine because stomata not very numerous (Plate 13*b*).

INTERSTOMATAL CELLS.—Long, narrow, width uniform to nonuniform; ends straight to convex; nonsinuuous. *Papillae*: None seen (Plate 13*b*).

LONG CELLS.—Long, narrow, width nonuniform or occasionally uniform; nonsinuuous. *Papillae*: None seen (Plate 13*a,c*).

PRICKLES.—Abundant to common; costal prickles. Abundant on margin and on two veins nearest margin but common on other veins (Plate 13*a,d*).

SHORT CELLS.—Costal solitary, paired, 3–5/row; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal infrequent; intercostal not seen (Plate 13*e,f*).

SILICA BODIES.—Costal oblong, elongated-

smooth or occasionally elongated-sinuuous; intercostal not seen (Plate 13 e,f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common to abundant; parallel; 2 stomatal bands/intercostal zone, 3 rows/band. Bands adjacent to veins (Plate 14 $a-c$).

INTERSTOMATAL CELLS.—Long, narrow, width uniform; ends straight to convex; nonsinuuous. *Papillae*: None seen (Plate 14 c).

LONG CELLS.—Rectangular to long, narrow, width uniform; nonsinuuous. *Papillae*: None seen (Plate 14 d).

PRICKLES.—Common; costal prickles. Basal portion of prickles very long (Plate 14 c,e,f).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 14 f).

SILICA BODIES.—Costal elongated-smooth; intercostal not seen (Plate 14 f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Vulpia bromoides (Linnaeus) S.F. Gray

PLATES 15–16

ABAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 15 b).

PRICKLES.—Infrequent; costal prickles (Plate 15 c).

SHORT CELLS.—Costal paired; intercostal paired or rarely 3–5/row. *Silica Cells*: Costal common; intercostal abundant. *Cork Cells*: Costal common; intercostal abundant (Plate 15 $d-f$).

SILICA BODIES.—Costal and intercostal crescent-shaped or sometimes tall and narrow, round (Plate 15 $d-f$).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

SPECIAL FEATURES.—Veins very prominent (Plate 15 a).

ADAXIAL

STOMATA.—Common; parallel; 2 stomatal bands/intercostal zone, 4 rows/band. Shape of subsidiary cell difficult to ascertain because of collapsed cells (Plate 16 b).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuuous. *Papillae*: None seen. Cells collapsed (Plate 16 b).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuuous. *Papillae*: None seen. Cells collapsed (Plate 16 a,c).

PRICKLES.—Abundant; costal and intercostal prickles, occasionally short macrohair type. Often partially collapsed as if not heavily silicified. Prickles primarily costal (Plate 16 d,e).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 16 d,f).

SILICA BODIES.—Costal oblong to elongated-smooth; intercostal not seen. Silica bodies have central horizontal ridge (Plate 16 d,f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Tribe BROMEAE

Bromus leptoclados Nees

PLATES 17–18

ABAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width nonuniform; nonsinuuous. *Papillae*: None seen (Plate 17 a,b).

PRICKLES.—Abundant; costal prickles (Plate 17 c).

SHORT CELLS.—Costal solitary, paired, 3–5/

row; intercostal solitary. *Silica Cells*: Costal abundant; intercostal infrequent (only one seen). *Cork Cells*: Costal abundant; intercostal not seen (Plate 17*a,d,e*).

SILICA BODIES.—Costal and intercostal oblong, midhorizontal ridge sometimes present (Plate 17*a,d,e*).

MICROHAIRS.—None seen.

MACROHAIRS.—Abundant; intercostal; basal cells absent (Plate 17*f*).

ADAXIAL

STOMATA.—Abundant; parallel to low-dome; 4 stomatal bands/intercostal zone, 1 row/band. Intercostal zones wide and veins indistinct (Plate 18*a,b*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 18*c*).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen (Plate 18*a,c,e*).

PRICKLES.—Infrequent; costal prickles primarily in marginal area (Plate 18*d*).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 18*e*).

SILICA BODIES.—Costal elongated-smooth, often with a midhorizontal ridge; intercostal not seen (Plate 18*e*).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; costal; basal cells absent (Plate 18*a,f*).

Tribe BRACHYPODIEAE

Brachypodium flexum Nees

PLATES 19-20

ABAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking, raised. *Papillae*:

None to 1/cell. Many long cells appear to have a raised area (papilla?) near the middle of cell opposite a silica body in an adjacent row of cells (Plate 19*b,c*).

PRICKLES.—Infrequent to common; costal and occasionally intercostal on the sides of the veins. Veins indistinct (Plate 19*a,d*).

SHORT CELLS.—Costal and intercostal solitary and paired. *Silica Cells*: Costal and intercostal common. *Cork Cells*: Costal and intercostal common (Plate 19*e,f*).

SILICA BODIES.—Costal and intercostal round or sometimes elliptical (Plate 19*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

Stomata.—Common; parallel; 2 stomatal bands/intercostal zone, 3 rows/band. Very collapsed and difficult to ascertain (Plate 20*b*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen. Cells collapsed and shape not always obvious (Plate 20*b*).

LONG CELLS.—Pentagonal, hexagonal or occasionally rectangular or long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen. Cells collapsed and shape not always obvious (Plate 20*a,c*).

PRICKLES.—Common; costal prickles, intercostal short macrohair type or occasionally hooks (Plate 20*c*).

SHORT CELLS.—Costal and intercostal solitary. *Silica Cells*: Costal and intercostal infrequent to common. *Cork Cells*: None seen (Plate 20*d,e*).

SILICA BODIES.—Costal tall and narrow or sometimes oblong, acutely angled, square; intercostal tall and narrow or sometimes acutely angled (Plate 20*d,e*).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; costal and sometimes intercostal; raised basal cells absent (Plate 20*f*).

Tribe TRITICEAE

Hordeum marinum Hudson

PLATES 21-22

ABAXIAL

STOMATA.—Infrequent to common; parallel; 3 stomatal bands/intercostal zone, 1 row/band (Plate 21*a,b*).

INTERSTOMATAL CELLS.—Rectangular; straight to convex; nonsinuous. *Papillae*: None seen. Shape and outline of walls difficult to determine because of collapsed cells and numerous prickles (Plate 21*c*).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen. Cells usually collapsed and shape difficult to determine (Plate 21*c*).

PRICKLES.—Abundant; costal and intercostal short macrohair-type prickles. Prickles quite variable in length from regular macrohair length to mainly short macrohair type (Plate 21*d,e*).

SHORT CELLS.—Costal and intercostal solitary. *Silica Cells*: Costal infrequent to common; intercostal infrequent. *Cork Cells*: Costal and intercostal absent (Plate 21*e,f*).

SILICA BODIES.—Costal elongated-smooth; intercostal round (Plate 21*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; intercostal and costal; raised basal cells absent. Most macrohairs are the short macrohair type (Plate 21*d,e*).

ADAXIAL

STOMATA.—Common; parallel to low-dome; 2 stomatal bands/intercostal zone; 1-2 rows/band. Pattern difficult to ascertain; interstomatal areas narrow; subsidiary cells collapsed (Plate 22*a-c*).

INTERSTOMATAL CELLS.—Rectangular; ends straight to convex; nonsinuous. *Papillae*: None seen. Shape difficult to determine because of folding (Plate 22*c*).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen.

Shape and outline difficult to determine because of wax and folding (Plate 22*a,c*).

PRICKLES.—Abundant; costal and intercostal straight, short macrohair type. Variable in length and many long enough to be classified as macrohairs (See Macrohairs) (Plate 22*a,d,e*).

SHORT CELLS.—Costal solitary, paired (?); intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal infrequent; intercostal not seen (Plate 22*d-f*).

SILICA BODIES.—Costal oblong, elongated-smooth, square; intercostal not seen. Some are very elongated (Plate 22*d-f*).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; costal and intercostal; basal cells absent (See Prickles) (Plate 22*a*).

Secale africanum Stapf

PLATES 23-24

ABAXIAL

STOMATA.—Infrequent to common; parallel; 2 stomatal bands/intercostal zone, 1 row/band. Stomata slightly sunken adjacent to veins and somewhat obscured by veins and macrohairs (Plate 23*a-c*).

INTERSTOMATAL CELLS.—Long, narrow, width uniform; end straight to convex; walls nonsinuous. *Papillae*: None seen (Plate 23*c*).

LONG CELLS.—Long, narrow, width uniform; nonsinuous. *Papillae*: None seen (Plate 23*c*).

PRICKLES.—None seen.

SHORT CELLS.—Costal solitary, paired, 3-5/row; intercostal not seen. *Silica Cells*: Costal infrequent to common; intercostal not seen. *Cork Cells*: Costal infrequent to common; intercostal not seen (Plate 23*d-f*).

SILICA BODIES.—Costal round, oblong, elongated-sinuous; intercostal not seen (Plate 23*d-f*).

MICROHAIRS.—None seen.

MACROHAIRS.—Abundant; intercostal and costal; raised basal cells absent. Major veins have macrohairs only on sides; minor veins have macrohairs on top (Plate 23*a-c*).

ADAXIAL

STOMATA.—Infrequent to common; parallel to low-dome; 2 stomatal bands/intercostal zone, 1 or 2 rows/band. Stomata slightly sunken adjacent to veins and somewhat obscured by veins and macrohairs (Plate 24*b,c*).

INTERSTOMATAL CELLS.—Square, rectangular, long, narrow, width uniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 24*c*).

LONG CELLS.—Pentagonal to long, narrow, width uniform; nonsinuous. *Papillae*: None seen (Plate 24*a,c,e*).

PRICKLES.—None seen.

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 24*d*).

SILICA BODIES.—Costal oblong; intercostal not seen (Plate 24*d*).

MICROHAIRS.—None seen.

MACROHAIRS.—Abundant; intercostal and costal; raised epidermal cells absent. Macrohairs vary in length (Plate 24*a,e,f*).

***Triticum aestivum* Linnaeus**

PLATES 25–26

ABAXIAL

STOMATA.—Common; low-dome; 2(?) stomatal bands/intercostal zone, 1 row/band. Veins broad and indistinct, distribution not clear (Plate 25*a,b*).

INTERSTOMATAL CELLS.—Square, rectangular, long, narrow, width uniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 25*c*).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen (Plate 25*a,d*).

PRICKLES.—None seen.

SHORT CELLS.—Costal solitary, paired(?). *Silica Cells*: Costal infrequent to common; intercostal not seen. *Cork Cells*: Costal infrequent to common(?); intercostal not seen. Cork cells indistinct;

some suggest a silica cell paired with a cork cell (Plate 25*e,f*).

SILICA BODIES.—Oblong, or sometimes elongated-sinuuous (Plate 25*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Abundant; parallel to low-dome; 2 stomatal bands/intercostal zone, 1 or sometimes 2 rows/band (Plate 26*a,b*).

INTERSTOMATAL CELLS.—Rectangular; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 26*c*).

LONG CELLS.—Long, narrow, width uniform; nonsinuous. *Papillae*: None seen. Mid-intercostal band of long cells with indistinct walls (Plate 26*a,d*).

PRICKLES.—None seen.

SHORT CELLS.—Solitary, sometimes paired, 3–5/row(?). *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal infrequent(?); intercostal not seen. Occasional paired silica cells (Plate 26*e,f*).

SILICA BODIES.—Costal elongated-sinuuous; intercostal not seen (Plate 26*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Tribe MELICEAE***Streblochaete longiarista* (A. Richard) Pilger**

PLATES 27–28

ABAXIAL

STOMATA.—Infrequent; parallel to low-dome; distribution indeterminable because stomata too infrequent (Plate 27*b*).

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 27*a,c*).

PRICKLES.—Common; costal and occasionally intercostal prickles (Plate 27*a,d*).

SHORT CELLS.—Costal and intercostal solitary. *Silica Cells*: Costal infrequent to common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 27*e,f*).

SILICA BODIES.—Costal oblong, elongated-sinu-ous; intercostal square (Plate 27*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common; parallel to low-dome; 2 stomatal bands/intercostal zone, 2 rows/band (Plate 28*a,b*).

INTERSTOMATAL CELLS.—Rectangular or some-times square or long, narrow, width uniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 28*b,c*).

LONG CELLS.—Pentagonal to long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen (Plate 28*a,c,e*).

PRICKLES.—Abundant; costal prickles and short, straight, macrohair type; intercostal hooks and short, straight, macrohair type. Some of the short macrohair type have sunken bases (Plate 28*d-f*).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent to common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 28*d*).

SILICA BODIES.—Costal oblong, elongated-smooth, square; intercostal not seen (Plate 28*d*).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; costal; basal cells ab-sent (Plate 28*e*).

Tribe AVENEAE

Aira caryophyllea Linnaeus

PLATES 29–30

ABAXIAL

STOMATA.—Abundant; parallel; 1 stomatal band/intercostal zone, 3 or 4 rows/band. Inter-

costal areas very narrow. Veins prominent and numerous. Shape of subsidiary cell difficult to ascertain because of collapsed cells (Plate 29*a,b*).

INTERSTOMATAL CELLS.—Rectangular to occa-sionally long, narrow, width uniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 29*c*).

LONG CELLS.—Long, narrow, width uniform; nonsinuous. *Papillae*: None seen (Plate 29*c,d*).

PRICKLES.—Abundant; costal prickles and short macrohair-type prickles (Plate 29*d*).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 29*d-f*).

SILICA BODIES.—Costal elongated-sinu-ous to occasionally elongated-smooth, square; intercos-tal not seen (Plate 29*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—See section on Prickles.

ADAXIAL

STOMATA.—Common; parallel; 1 stomatal band/intercostal zone, 3 or sometimes 1 row/band. Costal areas very prominent, intercostal very narrow (Plate 30*a,b*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 30*c*).

LONG CELLS.—Long, narrow, width uniform to occasionally nonuniform; nonsinuous. *Papillae*: None seen (Plate 30*a,c*).

PRICKLES.—Abundant; costal prickles and oc-casional hooks (Plate 30*d*).

SHORT CELLS.—Costal solitary, paired, 3–5/row; intercostal not seen. *Silica Cells*: Costal abun-dant; intercostal not seen. *Cork Cells*: Costal com-mon; intercostal not seen (Plate 30*e,f*).

SILICA BODIES.—Costal nodular or sometimes elongated-sinu-ous, square; intercostal not seen (Plate 30*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Anthoxanthum nivale* K. Schumann**

PLATES 31-32

ABAXIAL

STOMATA.—Infrequent to common; parallel; 2 stomatal bands/intercostal zone, 2 rows/band (Plate 31a).

INTERSTOMATAL CELLS.—Long, narrow, width uniform (often appearing nonuniform because of collapsed cells); ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 31b).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen (Plate 31c,d).

PRICKLES.—Infrequent; costal prickles (Plate 31e).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal infrequent; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 31f).

SILICA BODIES.—Costal elongated-smooth; intercostal not seen (Plate 31f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous (sometimes collapsed). Zones (approximately five cells wide) of uniform width cells alternate with nonuniform width cells. *Papillae*: None seen (Plate 32a-c).

PRICKLES.—Infrequent; costal prickles (Plate 32d-f).

SHORT CELLS.—None seen.

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Avena abyssinica* Hochstetter**

PLATES 33-34

ABAXIAL

STOMATA.—Common; parallel to low-dome; 2 stomatal bands/intercostal zone, 1-3 rows/band. Stomatal bands adjacent to veins (Plate 33a-c).

INTERSTOMATAL CELLS.—Long, narrow, width uniform to nonuniform (perhaps an artifact of folding); ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 33a).

LONG CELLS.—Long, narrow, width uniform to nonuniform (perhaps an artifact of folding); nonsinuous to slightly sinuous (marginal area). *Papillae*: None seen (Plate 33a).

PRICKLES.—Common; costal prickles (Plate 33c).

SHORT CELLS.—Costal paired, 3-5/row; intercostal not seen. *Silica Cells*: Costal abundant; intercostal not seen. *Cork Cells*: Costal abundant; intercostal not seen (Plate 33d).

SILICA BODIES.—Costal elongated-sinuous; intercostal not seen (Plate 33d).

MICROHAIRS.—None seen.

MACROHAIRS.—Infrequent to common; intercostal; basal cells absent. Primarily adjacent to midvein (Plate 33e,f).

ADAXIAL

STOMATA.—Common; parallel; 2 stomatal bands/intercostal zone, 1-3 rows/band (Plate 34b).

INTERSTOMATAL CELLS.—Long, narrow, width uniform to nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 34a,d).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen (Plate 34a,d).

PRICKLES.—Common; costal and intercostal prickles. Intercostal infrequent (Plate 34c).

SHORT CELLS.—Costal solitary, paired, 3-5/row; intercostal not seen. *Silica Cells*: Costal abundant; intercostal not seen. *Cork Cells*: Costal abundant; intercostal not seen (Plate 34a,d).

SILICA BODIES.—Costal elongated-sinuous; intercostal not seen (Plate 34a,d).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; costal; basal cells absent (Plate 34e,f).

***Deschampsia caespitosa* (Linnaeus) Beauvois
var. *oliveri* Hubbard**

PLATES 35-36

ABAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 35*b*).

PRICKLES.—Abundant; costal and intercostal prickles. Extremely abundant and uniformly distributed (Plate 35*a,c,d*).

SHORT CELLS.—Costal and intercostal solitary and paired. *Silica Cells*: Costal and intercostal abundant. *Cork Cells*: Costal and intercostal abundant (Plate 35*c,e,f*).

SILICA BODIES.—Costal and intercostal elliptical to round (Plate 35*c,e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

SPECIAL FEATURES.—Regular raised areas that appear to be veins, but epidermis in these costal zones and in the intercostal regions uniform (Plate 35*a*).

ADAXIAL

STOMATA.—Common; low-dome; 2 stomatal bands/intercostal zone, ca. 15 row/band. Intercostal zones very wide (Plate 36*a,b*).

INTERSTOMATAL CELLS.—Long, narrow, width uniform; ends straight to convex; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 36*a*).

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking raised. *Papillae*: None seen. In the center of each intercostal zone a narrow belt (2 or 3 cells wide) of waxy, nonsinuous long cells. On each side of the narrow belt a region containing markedly sinuous long cells (Plate 36*c*).

PRICKLES.—Common; costal prickles. Only along top of veins; usually a double row of mainly large but a few small ones on the side (Plate 36*d,e*).

SHORT CELLS.—Costal solitary or sometimes paired; intercostal solitary. *Silica Cells*: Costal and intercostal common. *Cork Cells*: Costal infrequent; intercostal not seen (Plate 36*d,f*).

SILICA BODIES.—Costal and intercostal elliptical, round (Plate 36*f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Helictotrichon elongatum* (Hochstetter)
Hubbard**

PLATES 37-38

ABAXIAL

STOMATA.—Common; parallel to low-dome; 2 stomatal bands/intercostal zone, 1 or 2 rows/band (Plate 37*a,b*).

INTERSTOMATAL CELLS.—Long, narrow, width uniform to nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 37*a*).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen (Plate 37*a,c*).

PRICKLES.—Common; costal prickles (on sides of veins) (Plate 37*d*).

SHORT CELLS.—Costal solitary, paired, 3-5/row; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal infrequent to common; intercostal not seen (Plate 37*e,f*).

SILICA BODIES.—Costal elongated-sinuous; intercostal not seen (Plate 37*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common; parallel to low-dome; 2 stomatal bands/intercostal zone, 1-3 rows/band. Bands adjacent to veins (Plate 38*b,c*).

INTERSTOMATAL CELLS.—Long, narrow, width uniform to nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 38*c*).

LONG CELLS.—Long, narrow, width uniform to

nonuniform; nonsinuuous. *Papillae*: None seen (Plate 38*a,d*).

PRICKLES.—Common; costal prickles (Plate 38*e*).

SHORT CELLS.—Costal solitary, paired, 3–5/row; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. Silica cells frequently solitary, alternating with prickles. *Cork Cells*: Costal infrequent to common; intercostal not seen (Plate 38*c,f*).

SILICA BODIES.—Costal elongated-sinuuous (many very long); intercostal not seen (Plate 38*c,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Koeleria capensis (Steudel) Nees

PLATES 39–40

ABAXIAL

STOMATA.—Common; low-dome; 2 stomatal bands/intercostal zone, 3 rows/band. Stomata are small, often collapsed, and difficult to observe in narrow intercostal zones sunken between large veins (Plate 39*a,b*).

INTERSTOMATAL CELLS.—Probably long, narrow. Shape and nature of walls not discernible because of collapsed cells. *Papillae*: None seen.

LONG CELLS.—Long, narrow, width uniform; nonsinuuous. *Papillae*: None seen (Plate 39*c*).

PRICKLES.—Abundant; costal prickles and short macrohairs (Plate 39*c,d*).

SHORT CELLS.—Costal solitary, rarely paired; intercostal not seen. *Silica Cells*: Costal abundant; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 39*c,e*).

SILICA BODIES.—Costal oblong, elongated-smooth, and square; intercostal not seen (Plate 39*e*).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; costal; basal cells absent (Plate 39*b,d,f*).

ADAXIAL

STOMATA.—None seen.

LONG CELLS.—Long, narrow, width uniform; nonsinuuous. *Papillae*: None seen (Plate 40*b,c*).

PRICKLES.—Abundant; costal prickles and short macrohairs (Plate 40*a–c*).

SHORT CELLS.—Costal paired, rarely solitary or 3–5/row; intercostal not seen. *Silica Cells*: Costal abundant; intercostal not seen. *Cork Cells*: Costal abundant; intercostal not seen (Plate 40*c–e*).

SILICA BODIES.—Costal oblong, elongated-smooth, and square; intercostal not seen (Plate 40*c–e*).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; intercostal; basal cells absent. Collapsed macrohairs are twisted (Plate 40*a,c,f*).

SPECIAL FEATURES.—Surface ridged because of wide, raised costal zones and narrow, sunken intercostal zones (Plate 40*a,c*).

Tribe PHALARIDEAE

Phalaris arundinacea Linnaeus

PLATES 41–42

ABAXIAL

STOMATA.—Abundant; parallel or sometimes low-dome; 2 stomatal bands/intercostal zone, 4 rows/band (Plate 41*a–c*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform; ends straight to convex; nonsinuuous. *Papillae*: None seen. Cell slightly raised (Plate 41*c*).

LONG CELLS.—Long, narrow, width uniform; nonsinuuous. *Papillae*: None seen (Plate 41*a,b,e*).

PRICKLES.—Common; costal prickles and intercostal hooks (Plate 41*a,d*).

SHORT CELLS.—Costal 3–5/row, 5/row, or sometimes paired; intercostal solitary, paired. *Silica Cells*: Costal common to abundant; intercostal common. *Cork Cells*: Costal common to abundant; intercostal infrequent (Plate 41*d–f*).

SILICA BODIES.—Costal square; intercostal square, round, crescent-shaped (Plate 41*d-f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Abundant; parallel to low-dome; 1 stomatal band/intercostal zone, 1 or sometimes 2 rows/band. Wax somewhat obscures the shape (Plate 42*a,b*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform; ends straight to convex; nonsinuous. *Papillae*: None seen. Cell slightly raised (Plate 42*c*).

LONG CELLS.—Rectangular to long, narrow, width uniform; nonsinuous. *Papillae*: None seen. Long cells adjacent to stomata slightly raised. Wax obscures cell outline (Plate 42*a,c,f*).

PRICKLES.—Infrequent; costal prickles and occasionally intercostal hooks (Plate 42*d*).

SHORT CELLS.—Costal solitary, paired (often two silica cells), 3–5/row; intercostal solitary. *Silica Cells*: Costal abundant; intercostal infrequent. *Cork Cells*: Costal abundant; intercostal not seen (Plate 42 *d-f*).

SILICA BODIES.—Costal oblong, square; intercostal square, crescent-shaped (Plate 42*d-f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

SPECIAL FEATURES.—Specimen very waxy.

Tribe AGROSTIDEAE

Agrostis schimperiana Hochstetter

PLATES 43–44

ABAXIAL

STOMATA.—Infrequent; parallel; 2 stomatal bands/intercostal zone, 1 row/band. Cells collapsed; intercostal zones very narrow; distribution not obvious (Plate 43*b*).

INTERSTOMATAL CELLS.—Long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 43*b*).

LONG CELLS.—Long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen. Cells often collapsed; width variable, with wider cells often over veins (Plate 43*a,c*).

PRICKLES.—Abundant; costal prickles (Plate 43*a,b,f*).

SHORT CELLS.—Costal solitary, paired, 3–5/row; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 43*d-f*).

SILICA BODIES.—Costal nodular; intercostal not seen. Some very long (Plate 43*d-f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common; parallel; 2 stomatal bands/intercostal zone, 2 rows/band (Plate 44*b,c*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 44*c*).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen. Veins numerous; long cells more collapsed in narrow intercostal regions (Plate 44*c,d*).

PRICKLES.—Abundant; costal prickles. Many prickles rather long and thin (Plate 44*e*).

SHORT CELLS.—Costal solitary; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen (Plate 44*d,f*).

SILICA BODIES.—Costal nodular; intercostal not seen. Silica bodies very long, often indistinct (Plate 44*d,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Calamagrostis epigeios (Linnaeus) Roth var. *capensis* Stapf

PLATES 45–46

ABAXIAL

STOMATA.—Common; parallel to low-dome; 1 stomatal band/intercostal zone, 1–3 rows/band (Plate 45*a,b,c*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform; ends straight to convex or slightly concave; nonsinuous. *Papillae*: None seen (Plate 45c).

LONG CELLS.—Long, narrow, width uniform; nonsinuous. *Papillae*: Cells adjacent to stoma have 1 papilla/cell; all other cells have none (Plate 45b).

PRICKLES.—Common; costal prickles (Plate 45d).

SHORT CELLS.—Costal solitary, 3–5/row, >5/row; intercostal solitary. *Silica Cells*: Costal infrequent to common; intercostal not seen. *Cork Cells*: Costal infrequent to common; intercostal common (Plate 45e,f).

SILICA BODIES.—Costal dumbbell with ends straight, middle wide and short, occasionally oblong or nodular; intercostal not seen (Plate 45e).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Abundant; parallel to low-dome; 2 stomatal bands/intercostal zone, 3–4 rows/band (Plate 46b).

INTERSTOMATAL CELLS.—Rectangular to square; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 46c).

LONG CELLS.—Long, narrow, width uniform; nonsinuous. *Papillae*: Occasionally cells adjacent to stoma have raised area; all other cells have none. Midintercostal area of raised long cells with no distinct boundaries, i.e., appears to be one enormous cell (Plate 46a,d).

PRICKLES.—Infrequent to common; costal and intercostal prickles, intercostal hooks. Intercostal larger and more frequent than costal prickles (Plate 46e).

SHORT CELLS.—Costal >5/row; intercostal solitary. *Silica Cells*: Costal abundant; intercostal not seen. *Cork Cells*: Costal abundant; intercostal common. Short cells are waxy (Plate 46f).

SILICA BODIES.—Costal dumbbell with ends straight, middle wide and short; intercostal not seen (Plate 46f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

Gastridium phleoides (Nees and Meyen) Hubbard

PLATES 47–48

ABAXIAL

STOMATA.—Common; parallel; 2 stomatal bands/intercostal zone, 1 row/band. Intercostal zones very narrow and sunken (Plate 47a,b).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 47c).

LONG CELLS.—Long, narrow, width uniform; nonsinuous. *Papillae*: None seen (Plate 47a,c).

PRICKLES.—Abundant; costal prickles, intercostal prickles and hooks (Plate 47d,e).

SHORT CELLS.—Costal solitary or sometimes paired, 3–5/row; intercostal paired. *Silica Cells*: Costal common; intercostal infrequent. *Cork Cells*: Costal infrequent to common; intercostal infrequent (Plate 47c–f).

SILICA BODIES.—Costal nodular, sometimes very short; intercostal not seen (Plate 47c–f).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common; parallel to low-dome; 2 stomatal bands/intercostal zone, 1 row/band (Plate 48a,b).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform or sometimes nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 48c).

LONG CELLS.—Long, narrow, width uniform to nonuniform; nonsinuous. *Papillae*: None seen (Plate 48c).

PRICKLES.—Abundant; costal prickles; intercostal prickles and hooks (Plate 48c,d).

SHORT CELLS.—Costal solitary and occasionally paired; intercostal not seen. *Silica Cells*: Costal

common; intercostal not seen. *Cork Cells*: Costal and intercostal not seen. The occasional pairs appear to be two silica cells (Plate 48*e,f*).

SILICA BODIES.—Costal nodular; intercostal not seen (Plate 48*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

***Polypogon monspeliensis* (Linnaeus)
Desfontaines**

PLATES 49-50

ABAXIAL

STOMATA.—Abundant; parallel to occasionally low-dome; 1 stomatal band/intercostal zone, 1 or 2 rows/band. Difficult to distinguish costal and intercostal zones (Plate 49*b,c*).

INTERSTOMATAL CELLS.—Long, narrow, width nonuniform to occasionally rectangular or square; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 49*c*).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen (Plate 49*a,c*).

PRICKLES.—Common; costal and occasional intercostal prickles (Plate 49*d,e*).

SHORT CELLS.—Costal solitary, paired; intercostal not seen. *Silica Cells*: Costal infrequent to common; intercostal not seen. *Cork Cells*: Costal infrequent to common; intercostal not seen. Costal zones difficult to distinguish from intercostal regions. Cork cells difficult to detect (Plate 49*e,f*).

SILICA BODIES.—Costal elongated-sinuous to nodular; intercostal not seen (Plate 49*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Common; parallel; 1 stomatal band/intercostal zone, 1-3 rows/band (Plate 50*a,b*).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width nonuniform; ends straight to convex; nonsinuous. *Papillae*: None seen (Plate 50*c*).

LONG CELLS.—Long, narrow, width nonuniform; nonsinuous. *Papillae*: None seen (Plate 50*a,c*).

PRICKLES.—Abundant; costal prickles and short, straight, macrohair-like prickles (Plate 50*d,f*).

SHORT CELLS.—Costal solitary, 3-5/row; intercostal not seen. *Silica Cells*: Costal common; intercostal not seen. *Cork Cells*: Costal common; intercostal not seen (Plate 50*e,f*).

SILICA BODIES.—Costal elongated-sinuous; intercostal not seen. Some very long (Plate 50*e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—See section on Prickles.

Tribe STIPEAE

***Stipa dregeana* Steudel**

PLATES 51-52

ABAXIAL

STOMATA.—Common; parallel to low-dome; 2 stomatal bands/intercostal zone, 1 row/band (Plate 51*a,b*).

INTERSTOMATAL CELLS.—Long, narrow, width uniform; ends straight to convex or slightly concave; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 51*c*).

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 51*a,e*).

PRICKLES.—Infrequent; costal prickles (Plate 51*d*).

SHORT CELLS.—Costal 3-5 row, >5/row; intercostal solitary. *Silica Cells*: Costal abundant; intercostal common. *Cork Cells*: Costal abundant; intercostal not seen (Plate 51*c,e,f*).

SILICA BODIES.—Costal dumbbell, ends rounded (with small terminal lobe), middle wide, long or short; intercostal elliptical (Plate 51*c,e,f*).

MICROHAIRS.—None seen.

MACROHAIRS.—None seen.

ADAXIAL

STOMATA.—Abundant; parallel to low-dome; 1-3 stomatal bands/intercostal zone, 1-4(?) rows/band. Costal regions hard to distinguish (Plate 52a-c).

INTERSTOMATAL CELLS.—Rectangular to long, narrow, width uniform, ends straight to convex to slightly concave; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 52c).

LONG CELLS.—Long, narrow, width uniform; markedly sinuous, interlocking, raised. *Papillae*: None seen (Plate 52a,c).

PRICKLES.—Infrequent; costal prickles (Plate 52a).

SHORT CELLS.—Costal paired, 3-5/row; >5/row; intercostal paired, 3-5/row. *Silica Cells*: Costal abundant; intercostal common. *Cork Cells*: Costal abundant; intercostal common (Plate 52d-f).

SILICA BODIES.—Costal dumbbell, ends rounded, middle wide, long or short, intercostal square, round, dumbbell, ends rounded, middle wide, long or short (Plate 52d-f).

MICROHAIRS.—None seen.

MACROHAIRS.—Common; intercostal and costal; basal cells absent (Plate 52f).

Appendix

Material Studied

<i>Species</i>	<i>Collection</i>	<i>Origin</i>	<i>Herbarium</i>
<i>Agrostis schimperiana</i>	Schlieben 4645	Tanganyika	MO
<i>Aira caryophyllea</i>	Morton 7069	Cameroon	K
<i>Anthoxanthum nivale</i>	Amshoff 1970	Ethiopia	MO
<i>Avena abyssinica</i>	Pappi 4901	Ethiopia	US
<i>Brachypodium flexum</i>	Davidse 5825	South Africa	MO
<i>Briza maxima</i>	Simon 2330	Rhodesia	MO
<i>Bromus leptoclados</i>	Maitland 1261	Cameroon	K
<i>Calamagrostis epigeios</i>	Greenway and Kanuri 14923	Kenya	MO
<i>Colpodium chionogeiton</i>	Wood 923	Tanzania	K
<i>Dactylis glomerata</i>	Gillett 15753	Jordan	US
<i>Deschampsia caespitosa</i> var. <i>oliveri</i>	Osmaston 3779	Uganda	US
<i>Festuca abyssinica</i>	Kerfoot 1732	Tanzania	K
<i>Gastridium phleoides</i>	Loubser 3224	South Africa	MO
<i>Helictotrichon elongatum</i>	Liebenberg 12	Uganda	US
<i>Hordeum marinum</i>	Bornmütter 11102	Egypt	US
<i>Koeleria capensis</i>	Taylor 3777	Kenya	MO
<i>Lolium temulentum</i>	Amshoff 1972	Ethiopia	MO
<i>Phalaris arundinacea</i>	Toosseus 1042	South Africa	US
<i>Poa schimperana</i>	Davidse 7070	Kenya	MO
<i>Polypogon monspeliensis</i>	Adam 18808	Mauritania	K
<i>Pseudobromus sylvaticus</i>	Robinson 5278	Nyasaland	MO
<i>Secale africanum</i>	Schweickerdt 7482	South Africa	US
<i>Stipa dregeana</i>	Schweickerdt 1818	South Africa	US
<i>Streblochaete longiarista</i>	Brenan 9512	British Cameroons	US
<i>Triticum aestivum</i>	Harshberger 1139	Algeria	US
<i>Vulpia bromoides</i>	Mooney 6348	Ethiopia	K

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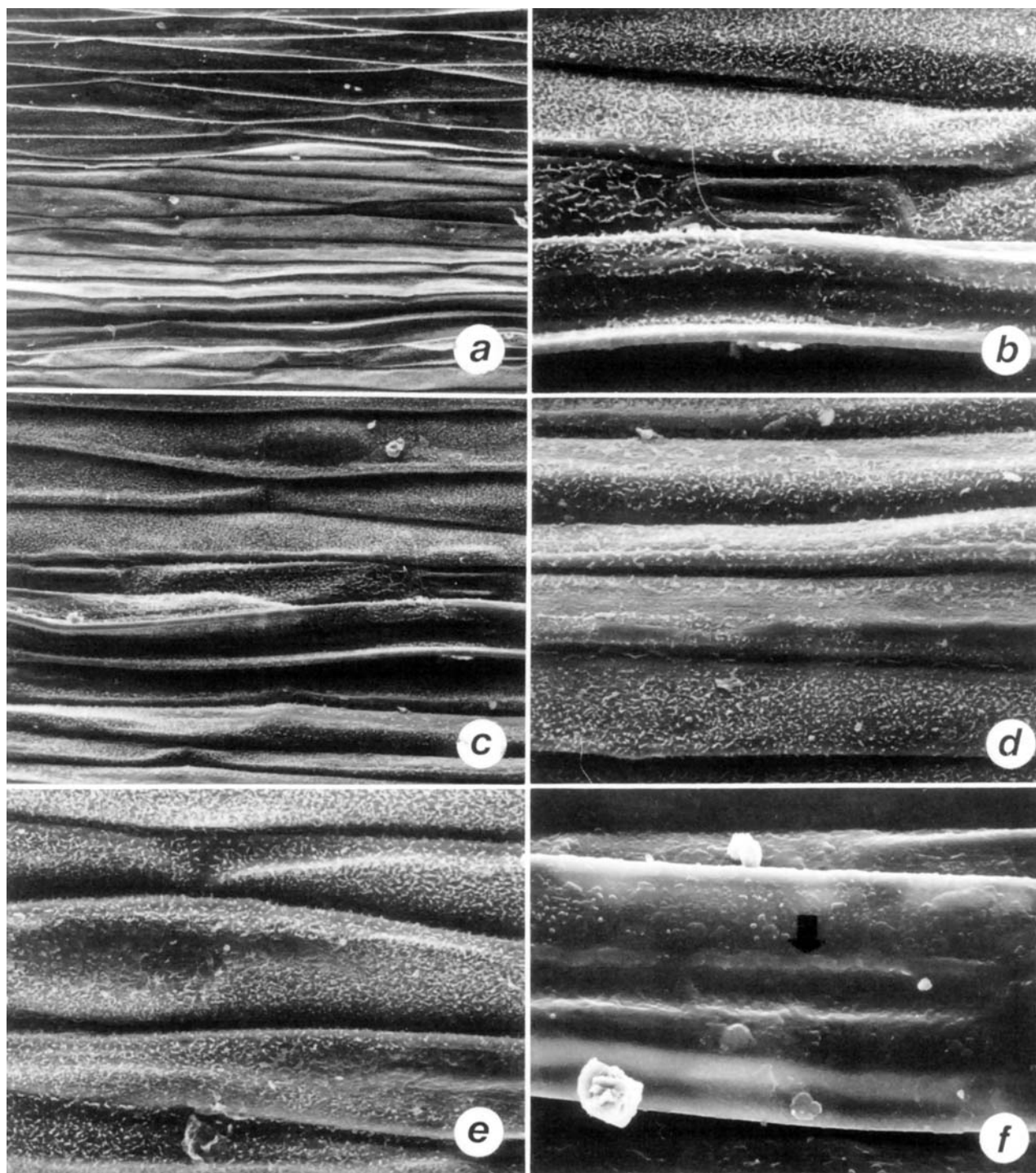


PLATE 1.—Abaxial epidermis *Briza maxima*, Simon 2330: *a*, overview, $\times 160$; *b*, stoma, $\times 640$; *c*, interstomatal cell, $\times 320$; *d*, uniform long cells, $\times 640$; *e*, nonuniform long cells, $\times 640$; *f*, silica body (arrow), $\times 867$.

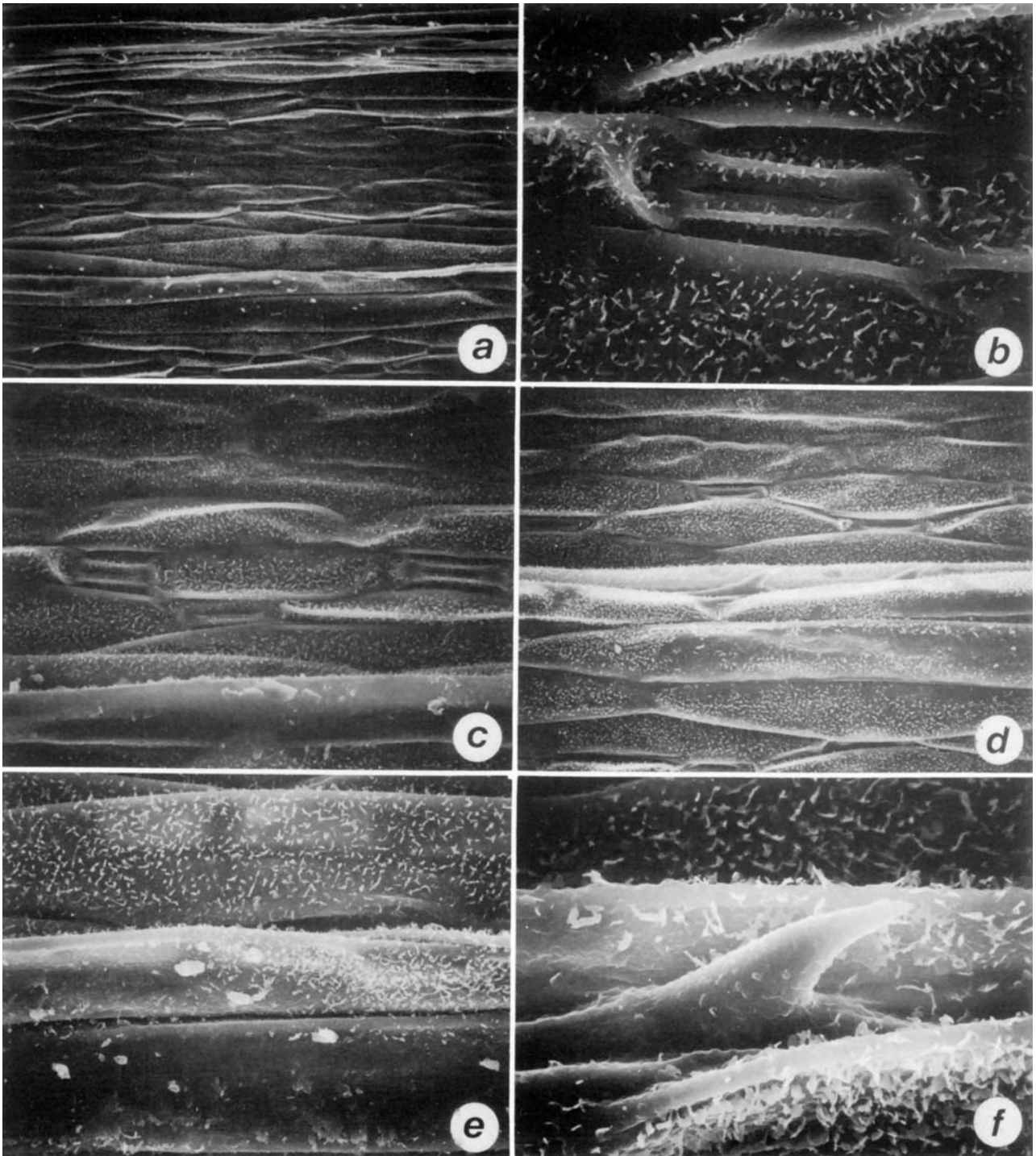


PLATE 2.—Adaxial epidermis *Briza maxima*, Simon 2330: *a*, overview, $\times 161$; *b*, stoma, $\times 1285$; *c*, interstomatal cell, $\times 416$; *d*, long cells, $\times 295$; *e*, long cells, $\times 625$; *f*, prickle, $\times 1696$.

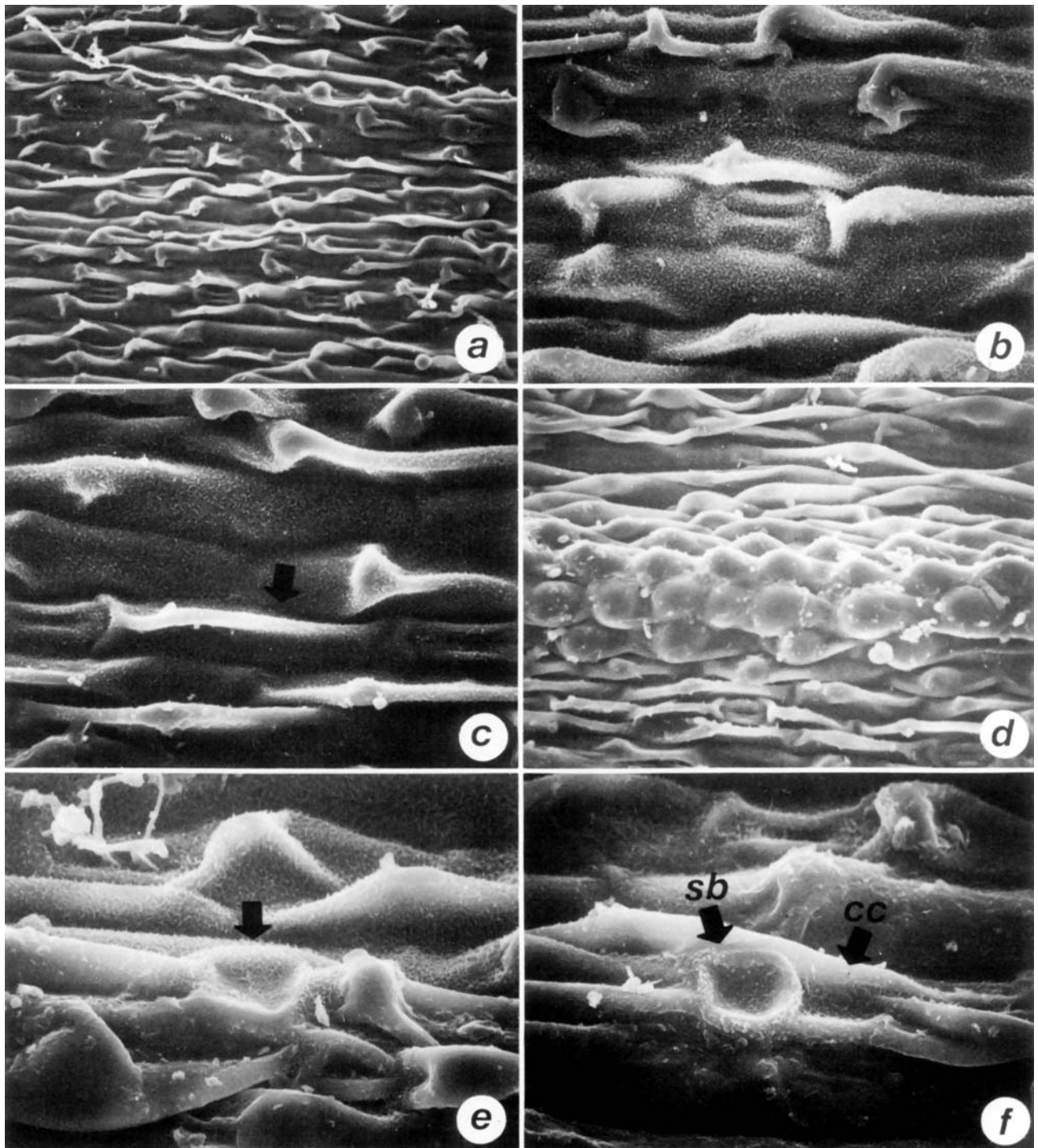


PLATE 3.—Abaxial epidermis *Colpodium chionogeton*, Wood 923: *a*, overview, $\times 295$; *b*, stoma, $\times 867$; *c*, interstomatal cells (arrow), long cells, $\times 867$; *d*, costal papillate prickles, $\times 416$; *e*, costal silica body (arrow), $\times 1285$; *f*, costal silica body (sb) and cork cell (cc), $\times 1285$.

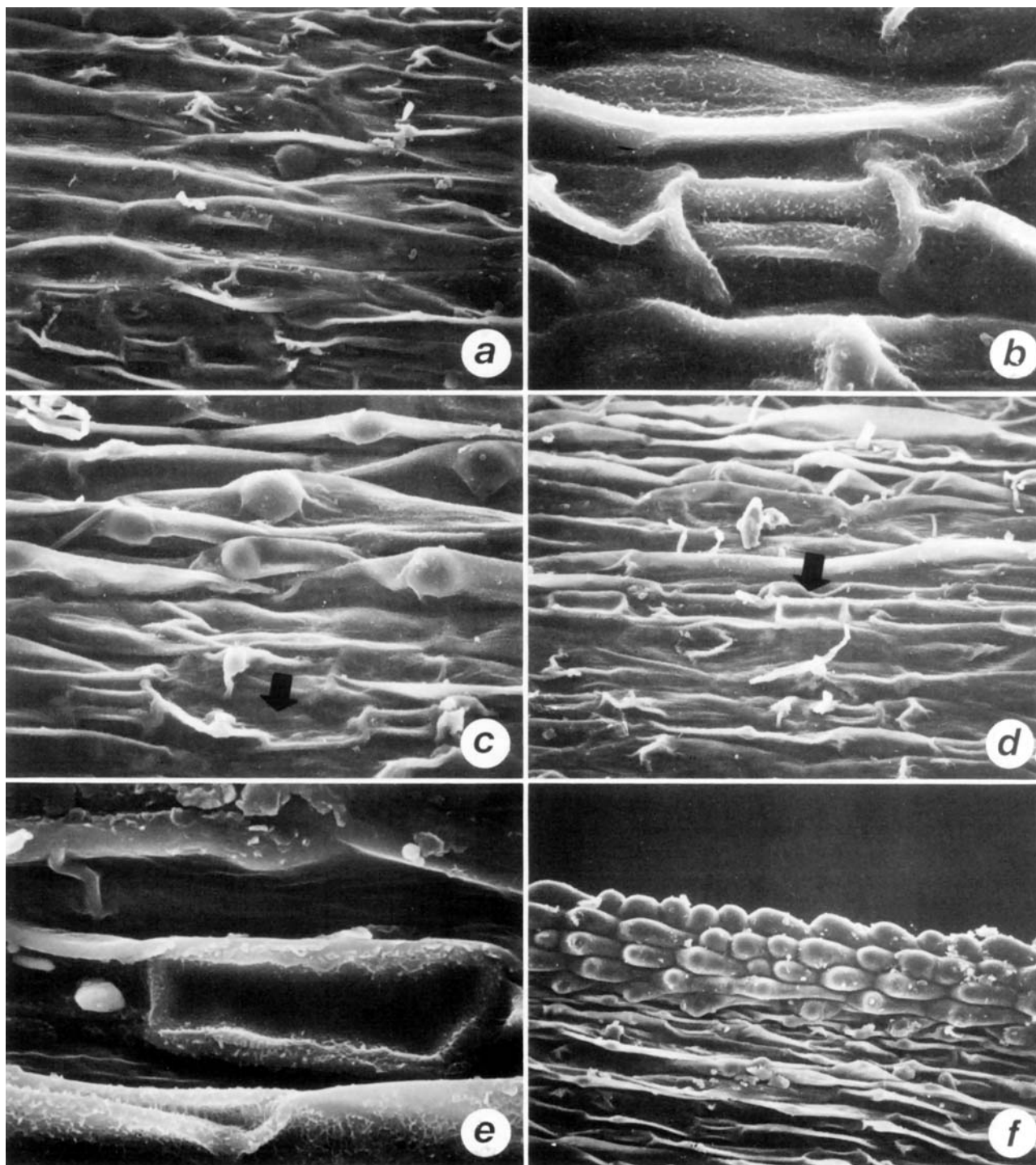


PLATE 4.—Adaxial epidermis *Colpodium chionogeiton*, Wood 923: *a*, overview, $\times 416$; *b*, stoma, $\times 1696$; *c*, long cells and interstomatal cell (arrow), $\times 625$; *d*, short cells (arrow), $\times 416$; *e*, silica body, $\times 1696$; *f*, marginal papillate-type prickles, $\times 295$.

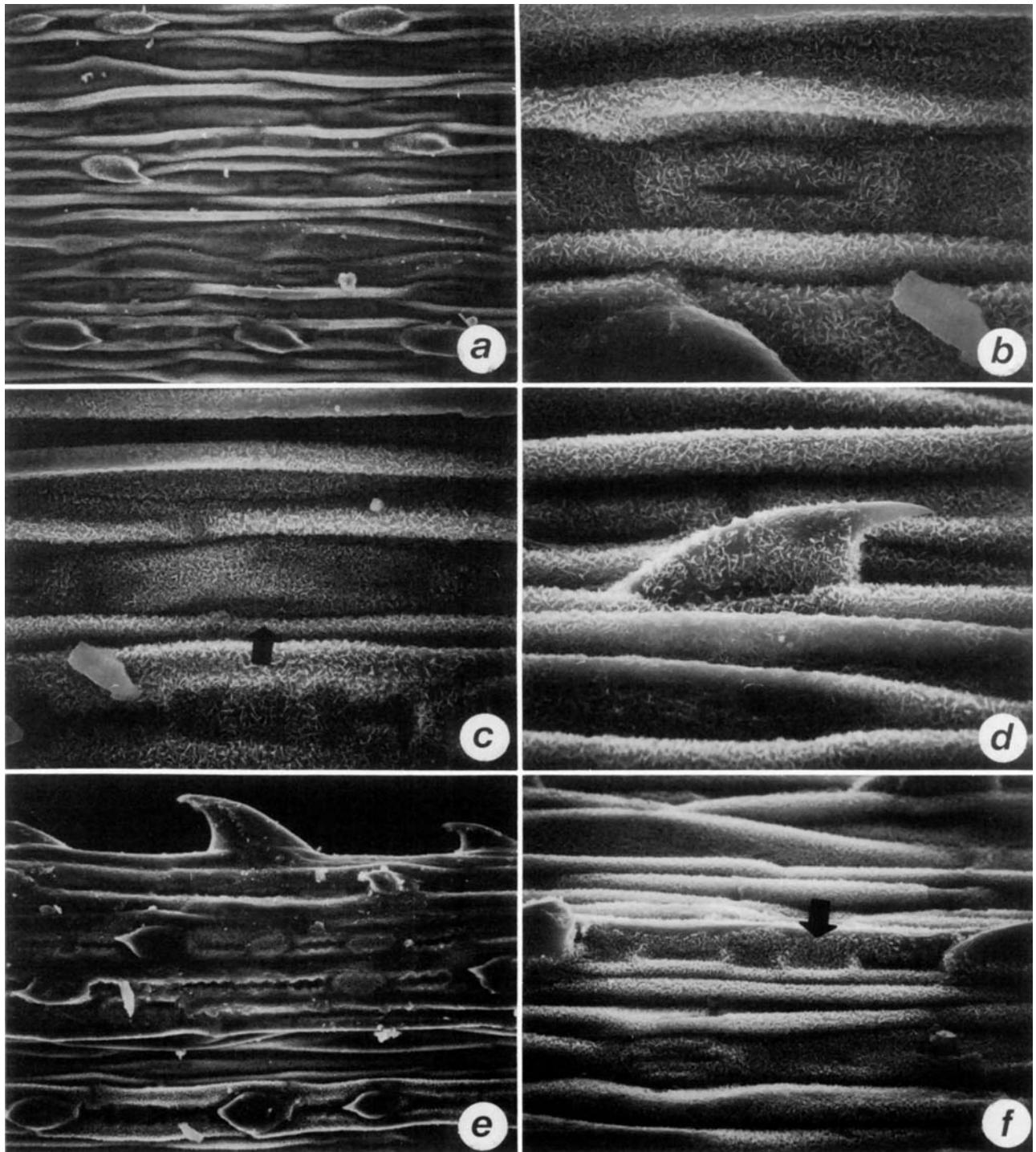


PLATE 5.—Abaxial epidermis *Dactylis glomerata*, Gillett 15753: *a*, overview, $\times 295$; *b*, stoma, $\times 1285$; *c*, interstomatal cell (arrow), $\times 867$; *d*, prickles, $\times 1285$; *e*, marginal area, prickles, short cells, $\times 295$; *f*, silica bodies (arrow), $\times 625$.

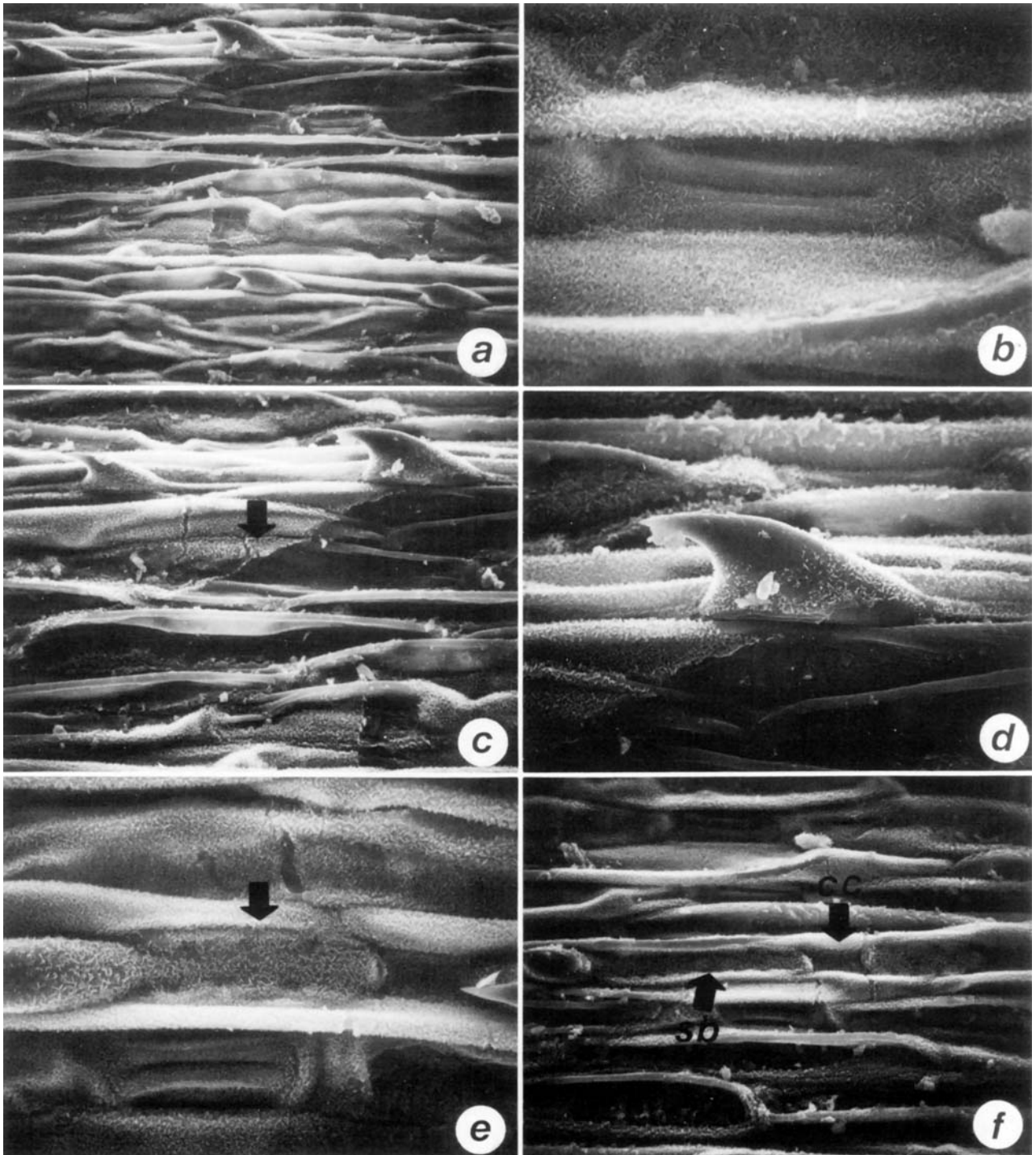


PLATE 6.—Adaxial epidermis *Dactylis glomerata*, Gillett 15753: *a*, overview, $\times 295$; *b*, stoma, $\times 1285$; *c*, interstomatal cell (arrow), $\times 416$; *d*, prickle, $\times 867$; *e*, silica body (arrow), $\times 867$; *f*, silica bodies (sb), cork cells (cc), $\times 416$.

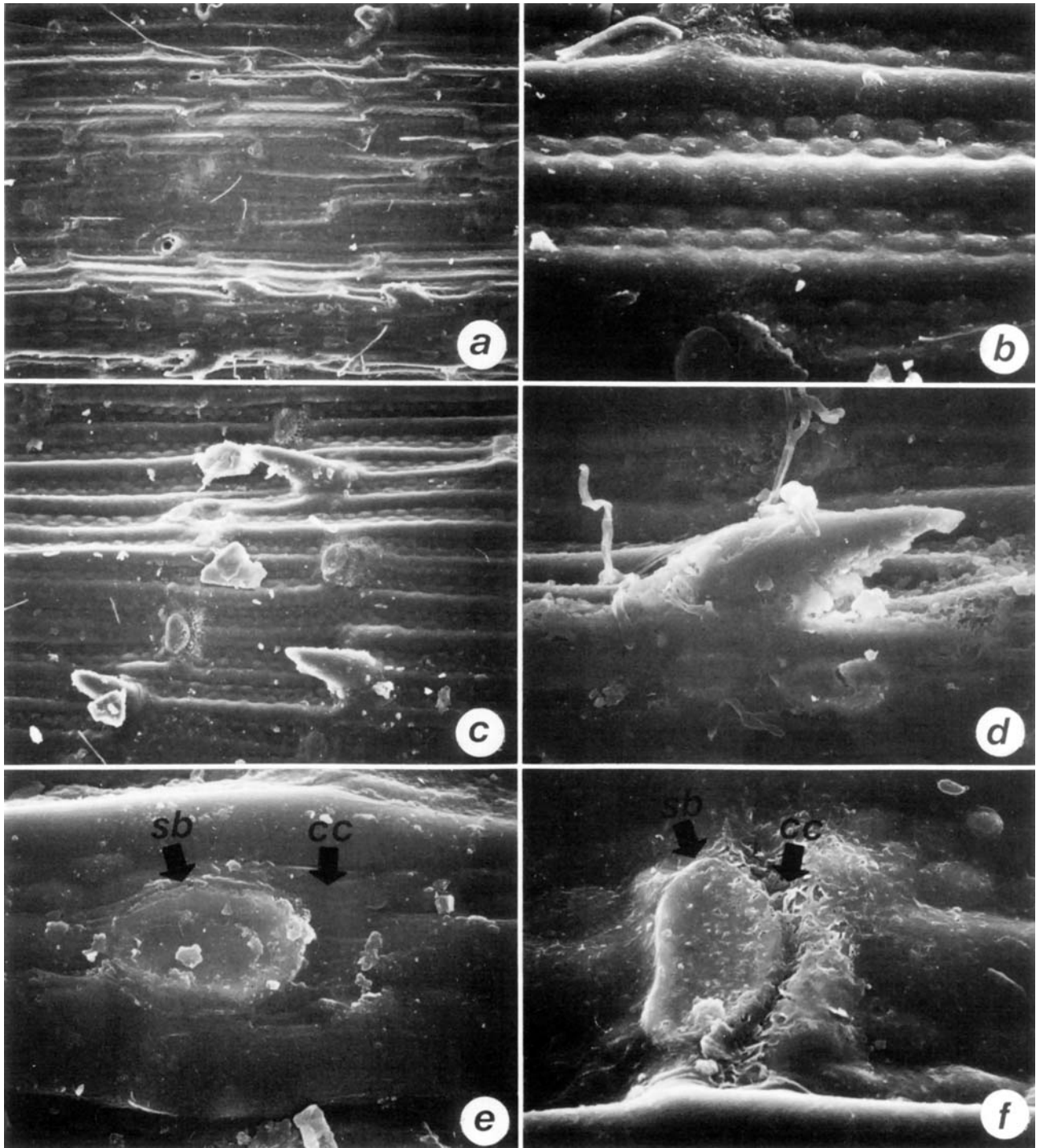


PLATE 7.—Abaxial epidermis *Festuca abyssinica*, Kerfoot 1732: *a*, overview, $\times 161$; *b*, long cells, $\times 867$; *c*, long cells, intercostal prickles, $\times 295$; *d*, costal prickle, $\times 867$; *e*, costal silica body (sb) and cork cell (cc), $\times 1696$; *f*, costal silica body (sb) and cork cell (cc), $\times 1696$.

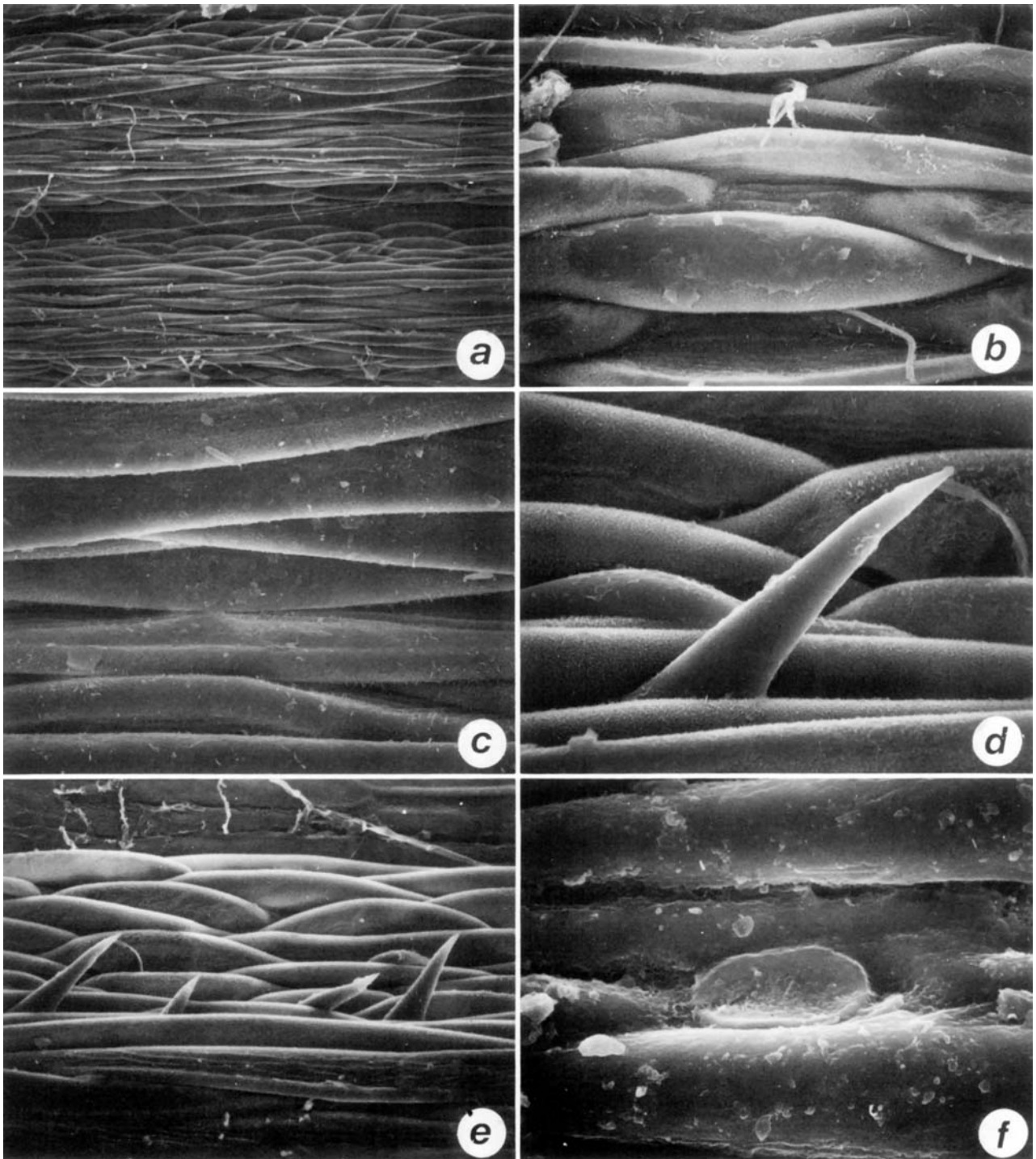


PLATE 8.—Adaxial epidermis *Festuca abyssinica*, Kerfoot 1732: *a*, overview, $\times 161$; *b*, stoma, $\times 867$; *c*, intercostal long cells, $\times 867$; *d*, short macrohair-type prickles, $\times 1285$; *e*, overview with prickles, $\times 416$; *f*, intercostal silica body, $\times 1696$.

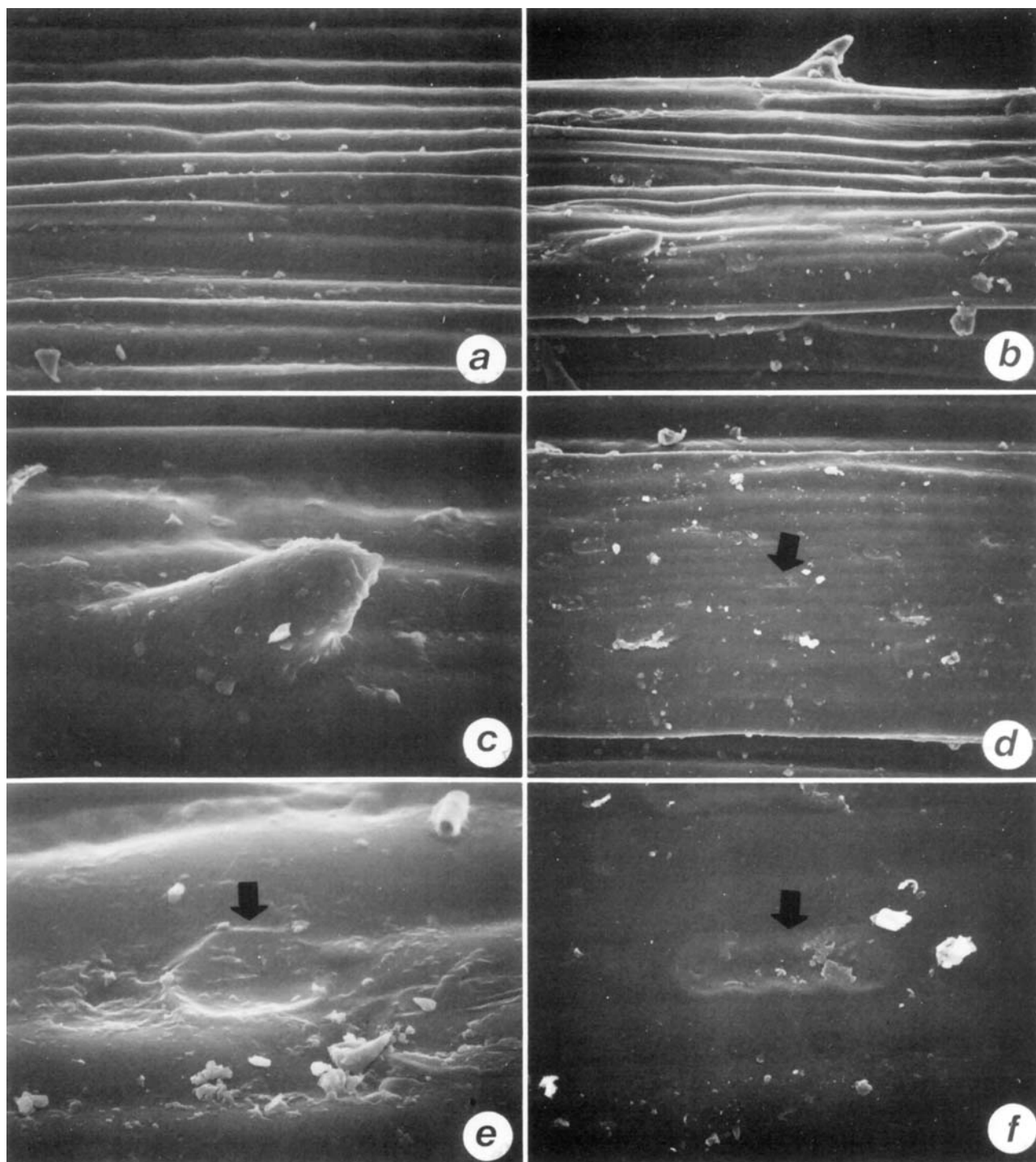


PLATE 9.—Abaxial epidermis *Lolium temulentum*, Amshoff 1972: *a*, overview, long cells, $\times 295$; *b*, marginal zone, prickle, $\times 295$; *c*, marginal prickle, $\times 1285$; *d*, midvein with short cells (arrow), $\times 295$; *e*, marginal silica body (arrow), $\times 1696$; *f*, silica body (arrow) on midvein $\times 1285$.

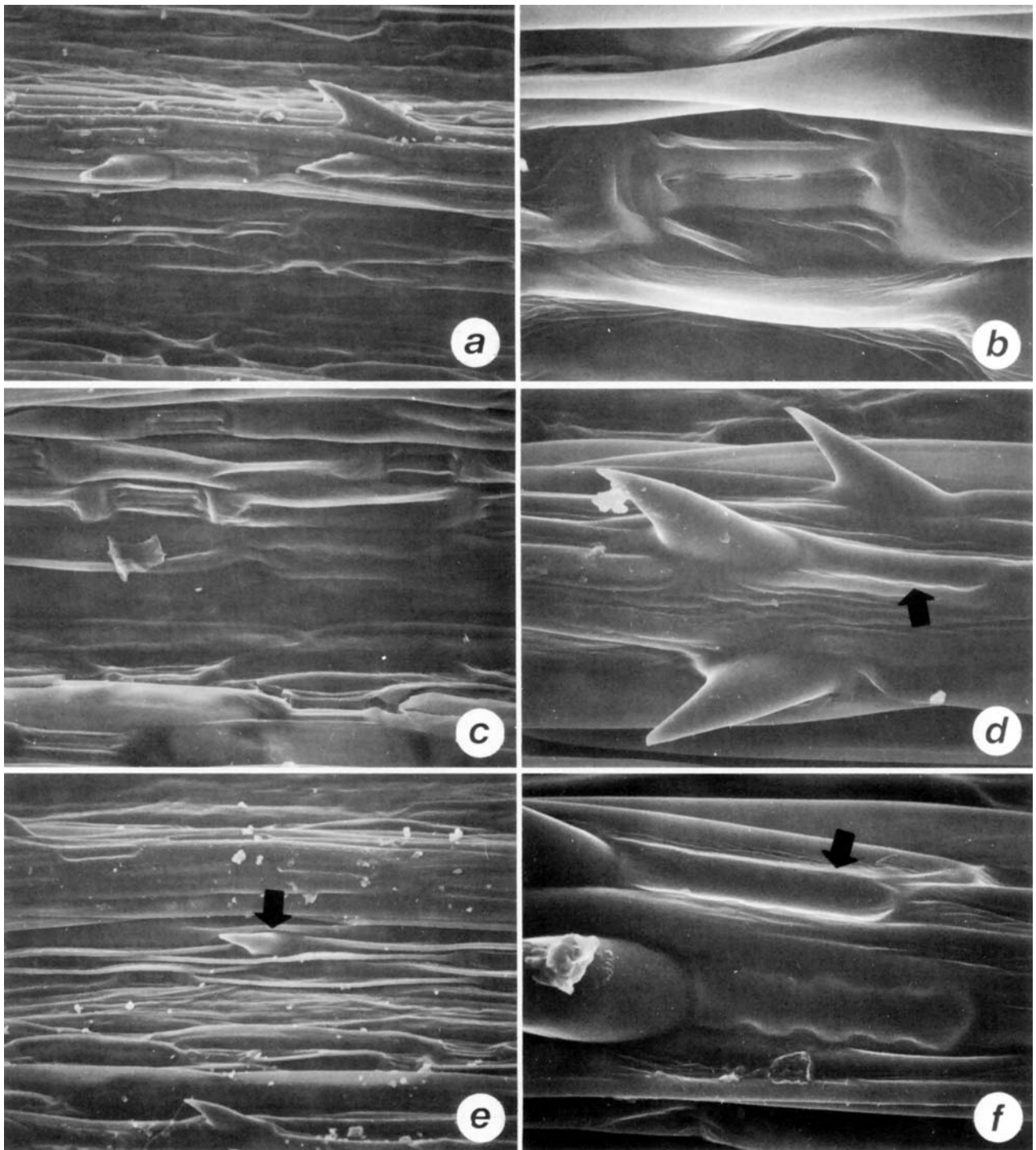


PLATE 10.—Adaxial epidermis *Lolium temulentum*, Amshoff 1972: *a*, overview, $\times 295$; *b*, stoma, $\times 1285$; *c*, stomatal bands, $\times 416$; *d*, costal prickles, silica body (arrow), $\times 625$; *e*, intercostal prickle (arrow), $\times 295$; *f*, costal silica bodies (arrow), $\times 867$.

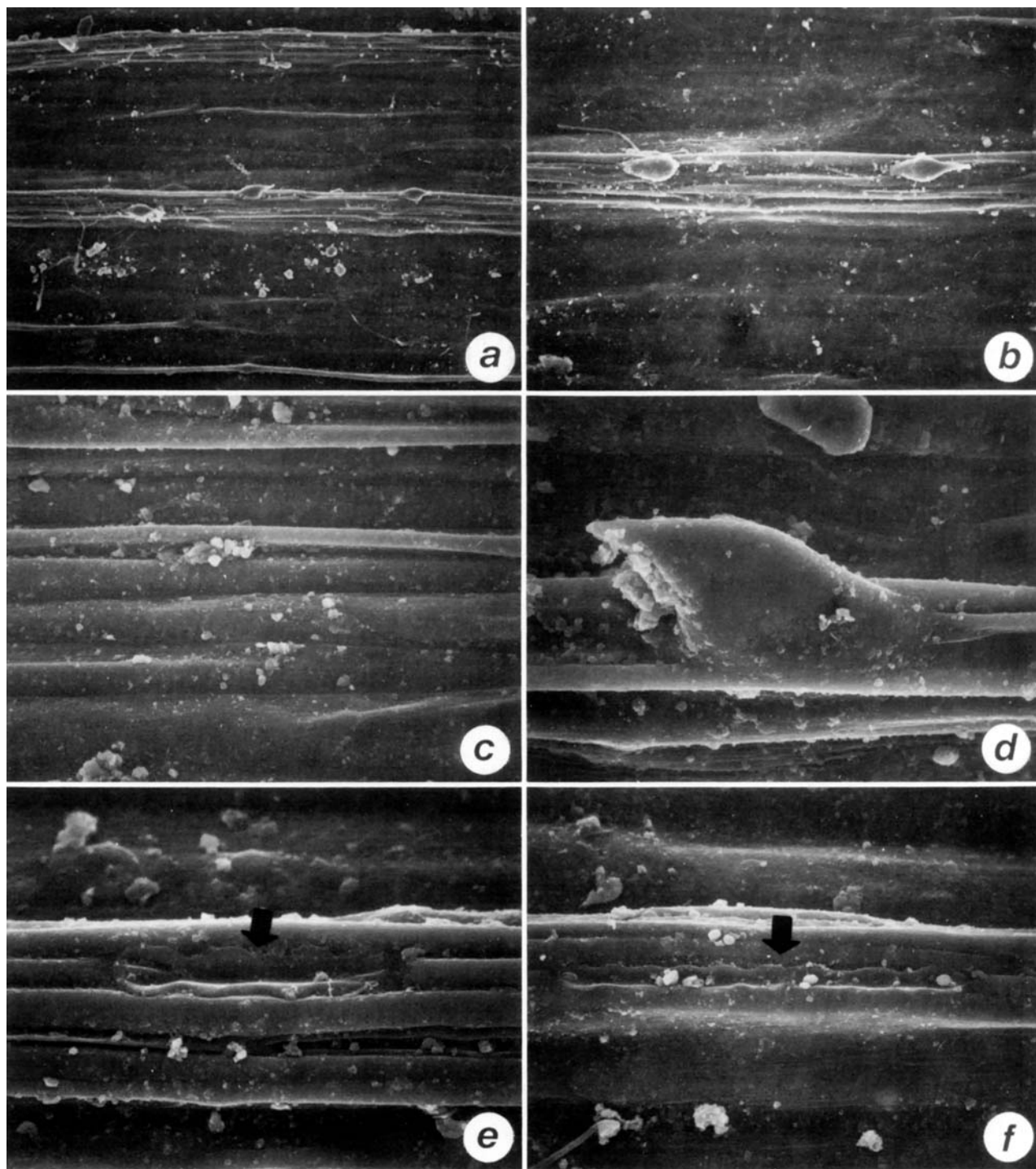


PLATE 11.—Abaxial epidermis *Poa schimperana*, Davidse 7070: *a*, overview, $\times 161$; *b*, overview, prickles, $\times 295$; *c*, long cells, $\times 625$; *d*, costal prickle, $\times 1285$; *e*, costal silica body (arrow), $\times 1285$; *f*, very long costal silica body (arrow), $\times 867$.

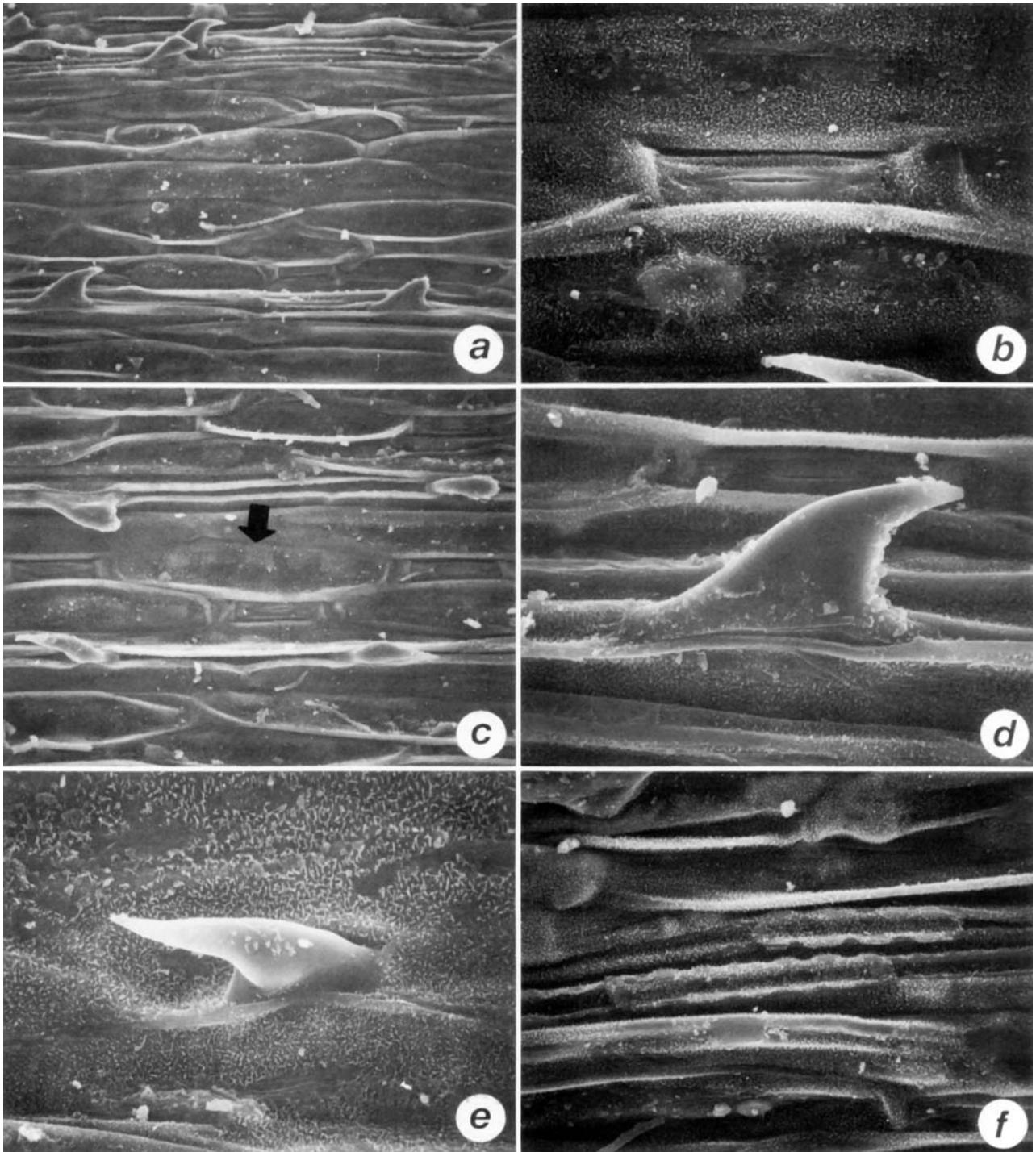


PLATE 12.—Adaxial epidermis *Poa schimperana*, Davidse 7070: *a*, overview, $\times 295$; *b*, stoma, $\times 1285$; *c*, interstomatal cell (arrow), $\times 416$; *d*, costal prickle, $\times 1285$; *e*, intercostal prickle, $\times 1285$; *f*, costal silica bodies, $\times 867$.

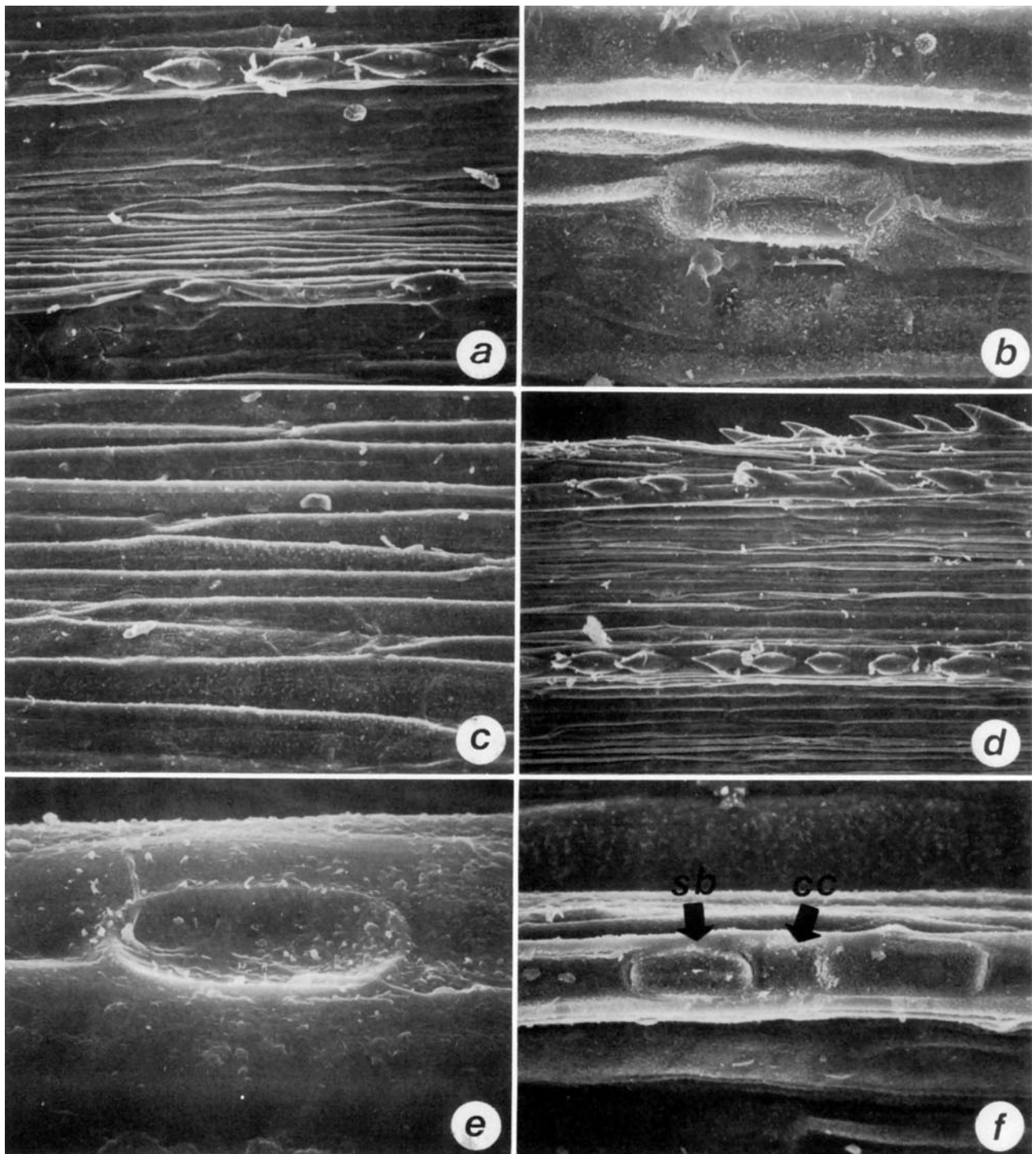


PLATE 13.—Abaxial epidermis *Pseudobromus sylvaticus*, Robinson 5278: *a*, overview, $\times 161$; *b*, stoma, $\times 867$; *c*, long cells, $\times 416$; *d*, costal prickles, $\times 121$; *e*, silica body, $\times 1696$; *f*, silica bodies (sb), cork cell (cc), $\times 625$.

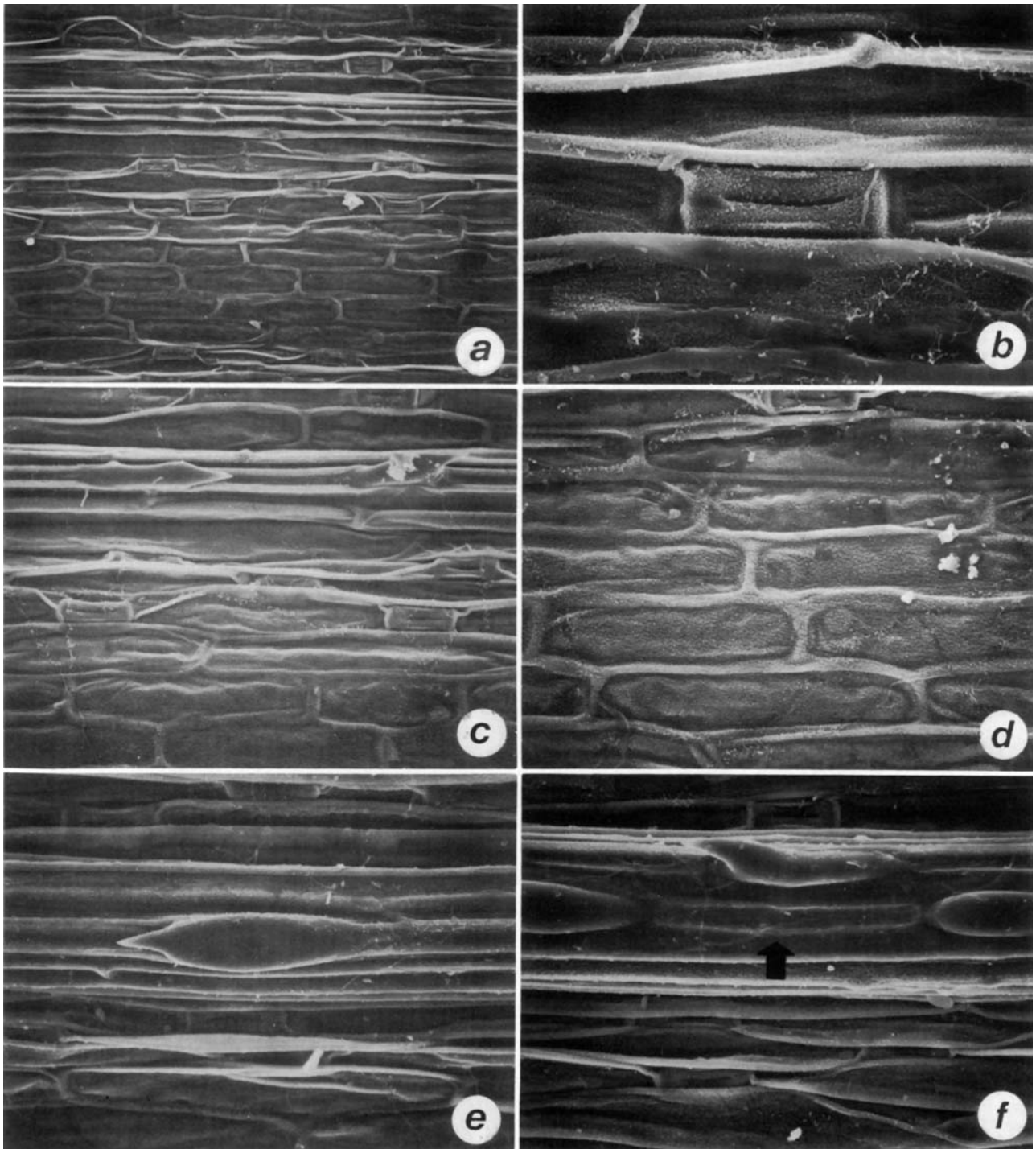


PLATE 14.—Adaxial epidermis *Pseudobromus sylvaticus*, Robinson 5278: *a*, overview, $\times 161$; *b*, stoma, $\times 867$; *c*, interstomatal and long cells, $\times 295$; *d*, long cells, $\times 416$; *e*, costal prickles, $\times 416$; *f*, costal silica body (arrow), $\times 416$.

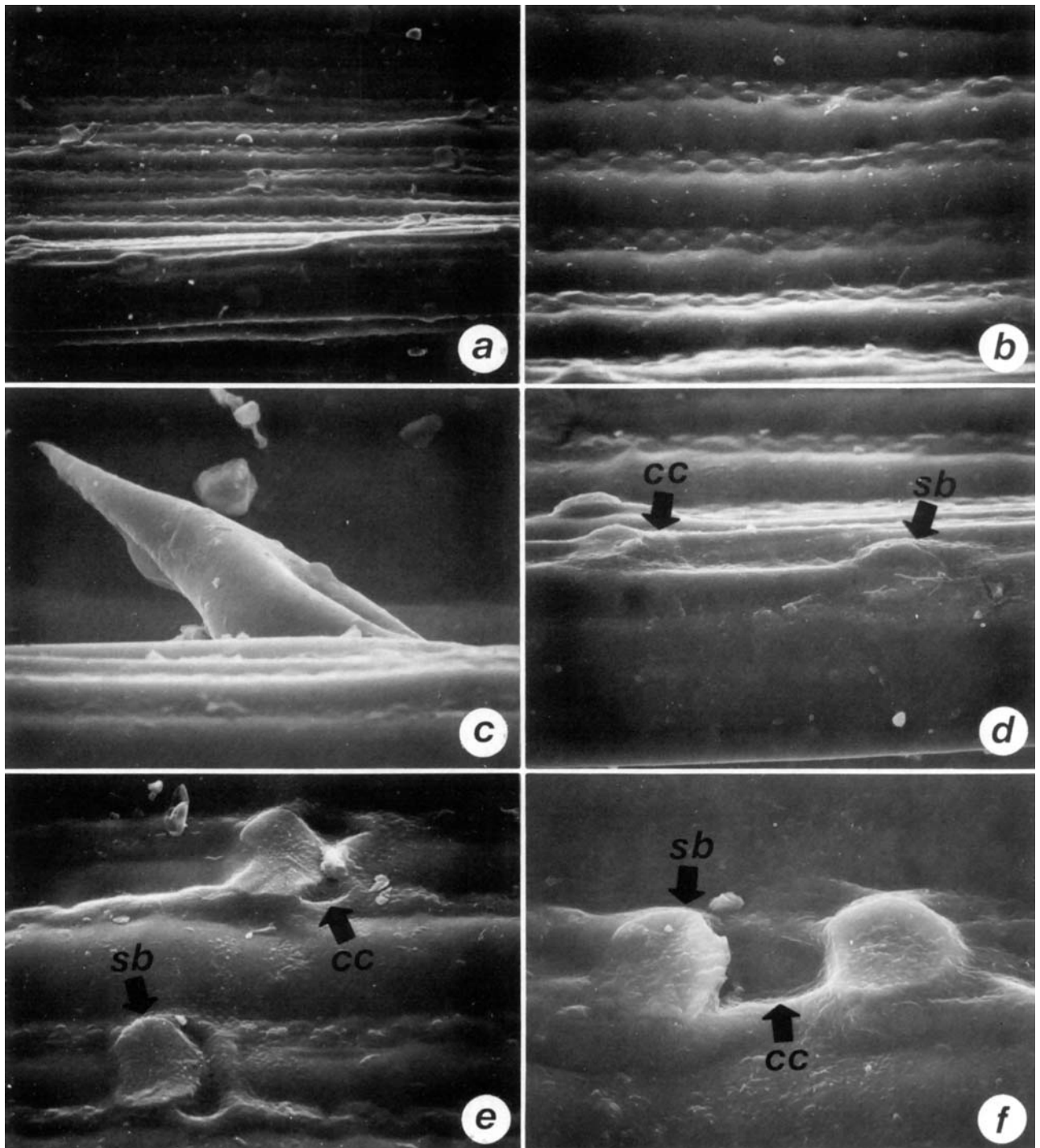


PLATE 15.—Abaxial epidermis *Vulpia bromoides*, Mooney 6348: *a*, overview, $\times 295$; *b*, long cells, $\times 867$; *c*, costal prickle, $\times 1696$; *d*, costal silica bodies (sb) and cork cells (cc), $\times 1285$; *e*, intercostal silica bodies (sb) and cork cells (cc), $\times 1285$; *f*, intercostal silica bodies (sb) and cork cell (cc), $\times 1696$.

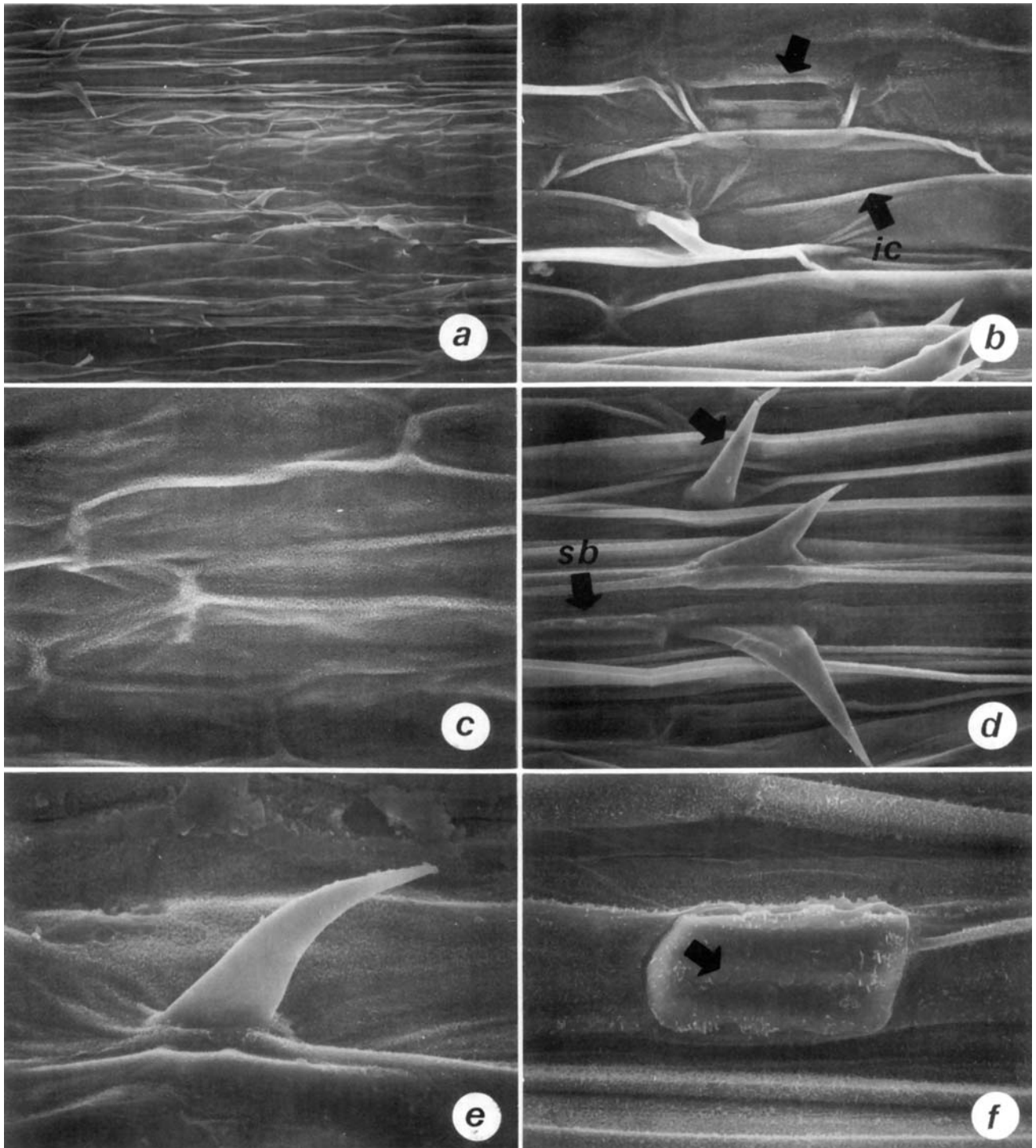


PLATE 16.—Adaxial epidermis *Vulpia bromoides*, Mooney 6348: *a*, overview, $\times 161$; *b*, stoma (arrow), interstomatal cell (ic), $\times 625$; *c*, long cells, $\times 625$; *d*, costal and intercostal (arrow) prickles, silica body (sb), $\times 625$; *e*, intercostal prickle, $\times 1285$; *f*, costal silica body with horizontal ridge (arrow), $\times 1696$.

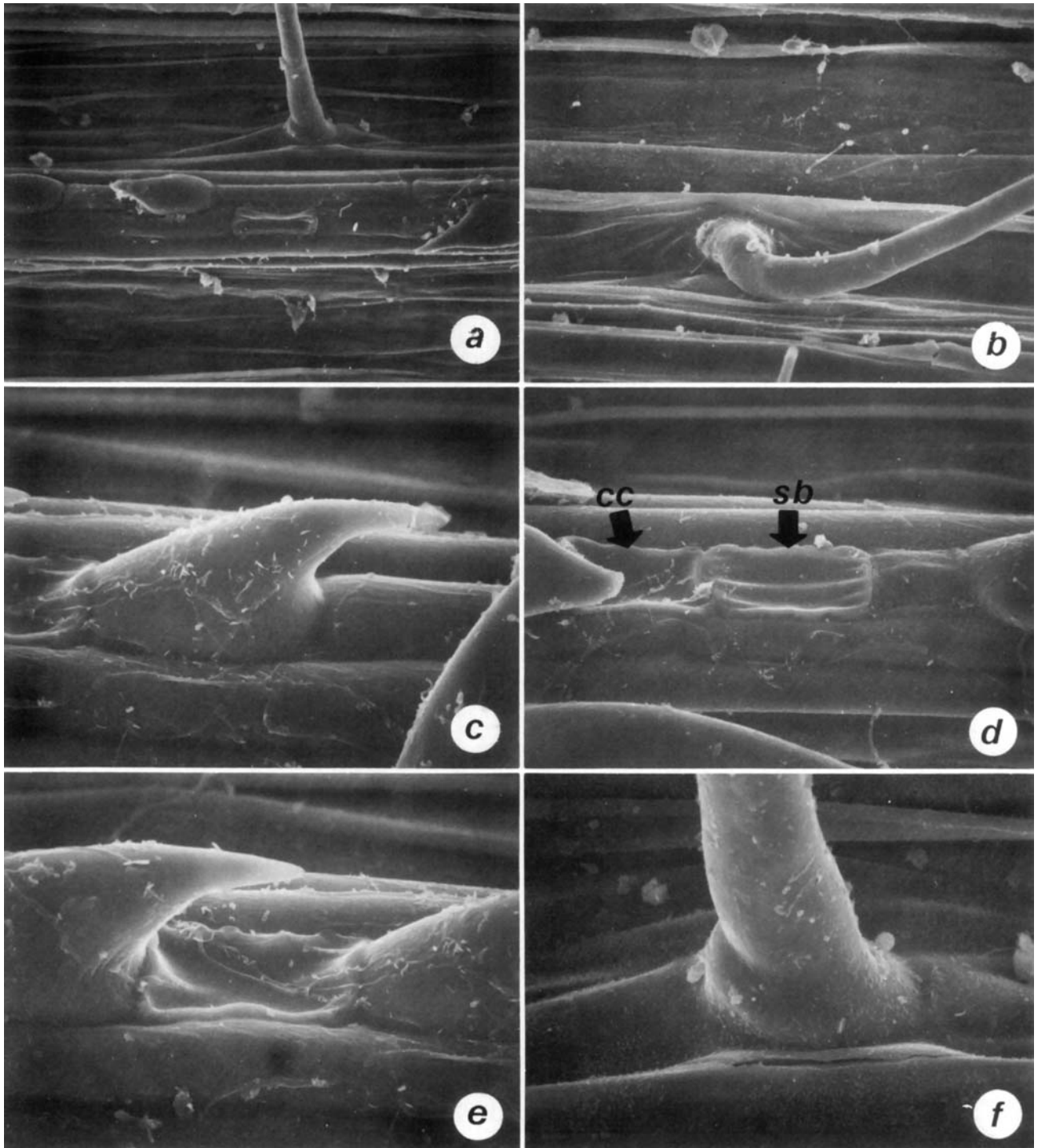


PLATE 17.—Abaxial epidermis *Bromus leptoclados*, Maitland 1261: *a*, overview, $\times 295$; *b*, long cells, macrohair, $\times 416$; *c*, costal prickle, $\times 1285$; *d*, costal silica body (sb) and cork cells (cc), $\times 867$; *e*, costal silica body, $\times 1285$; *f*, base of macrohair, $\times 1285$.

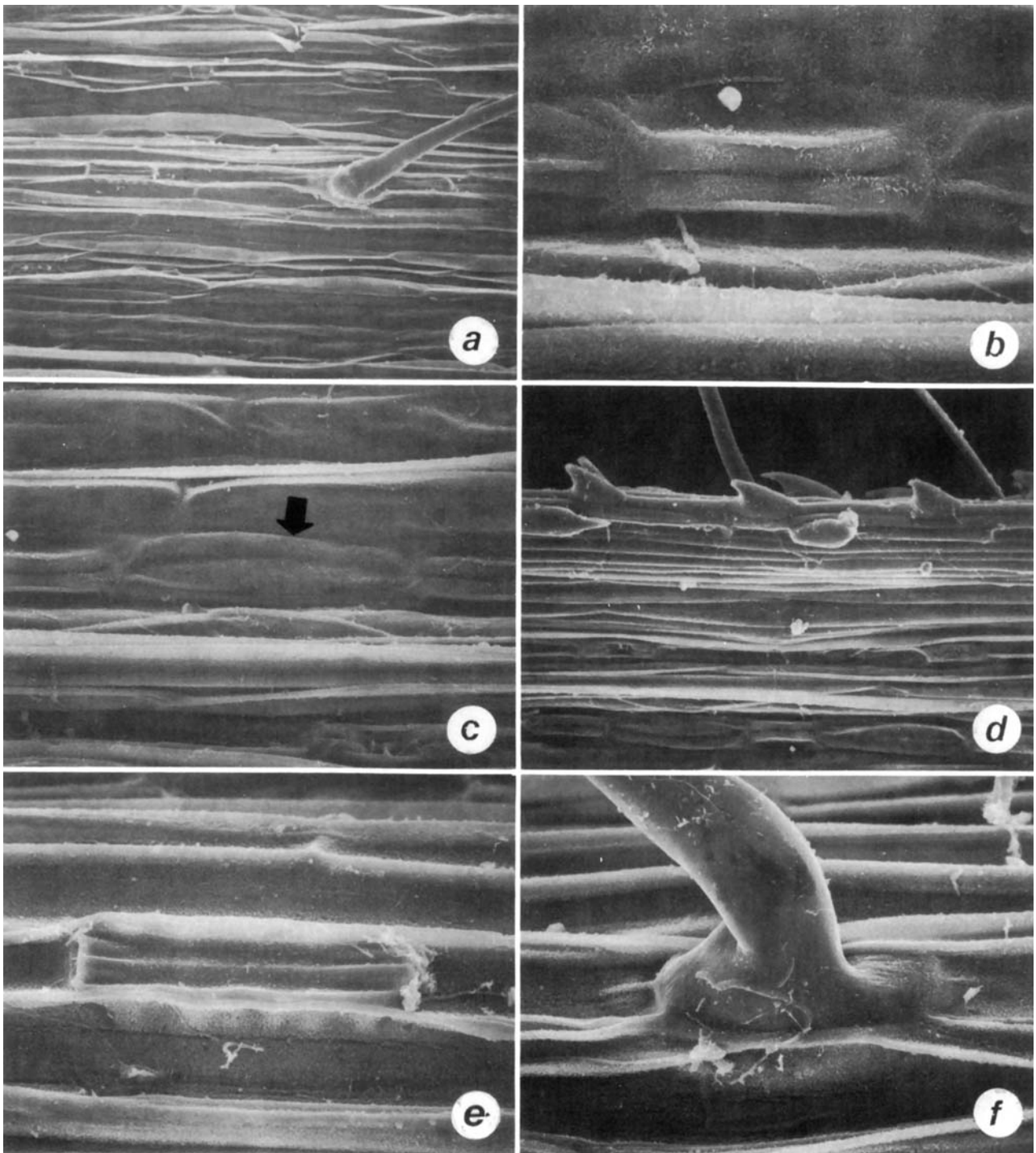


PLATE 18.—Adaxial epidermis *Bromus leptoclados*, Maitland 1261: *a*, overview, $\times 161$; *b*, stoma, $\times 1285$; *c*, interstomatal cell (arrow), $\times 625$; *d*, marginal area, $\times 295$; *e*, costal silica body, $\times 867$; *f*, base of macrohair, $\times 867$.

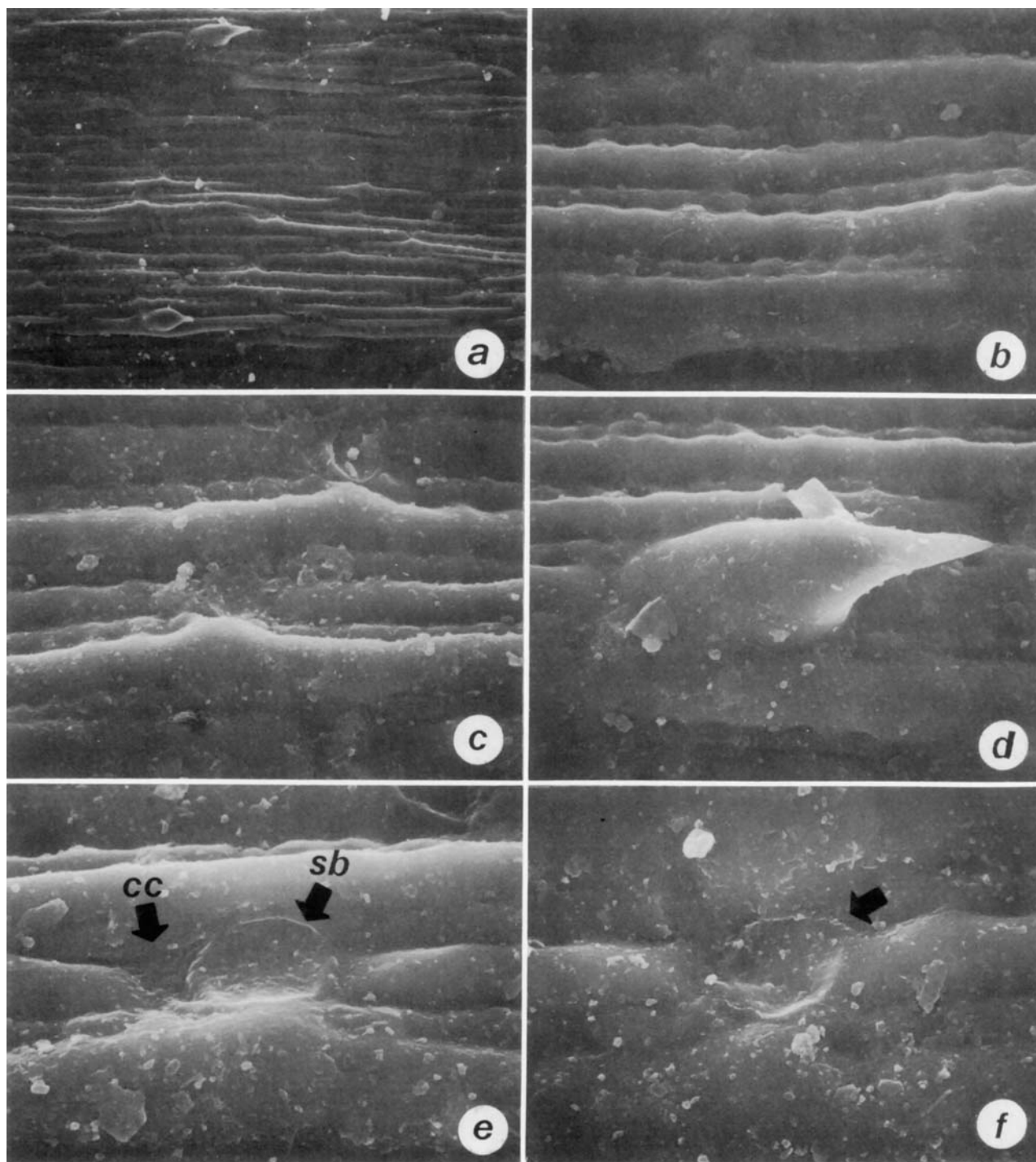


PLATE 19.—Abaxial epidermis *Brachypodium flexum*, Davidse 5825: *a*, overview, $\times 295$; *b*, long cells, $\times 1696$; *c*, papillae on long cells, $\times 1696$; *d*, costal prickle, $\times 1696$; *e*, costal silica body (sb) and cork cell (cc), $\times 2970$; *f*, intercostal silica body (arrow), $\times 2970$.

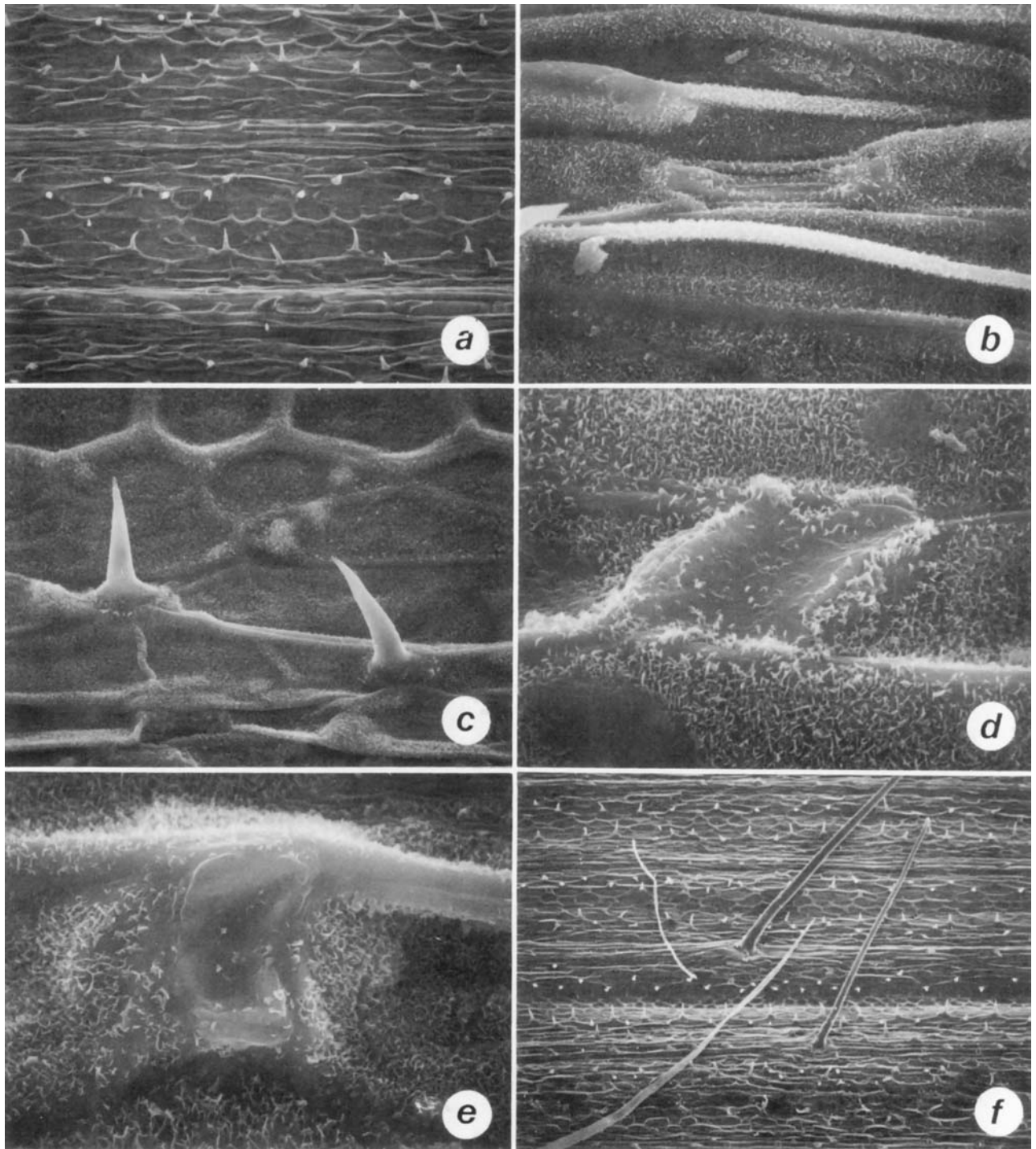


PLATE 20.—Adaxial epidermis *Brachypodium flexum*, Davidse 5825: *a*, overview, $\times 161$; *b*, stoma, $\times 1696$; *c*, intercostal short macrohairs, $\times 867$; *d*, costal silica body, $\times 2970$; *e*, intercostal silica body, $\times 2970$; *f*, macrohairs, $\times 80$.

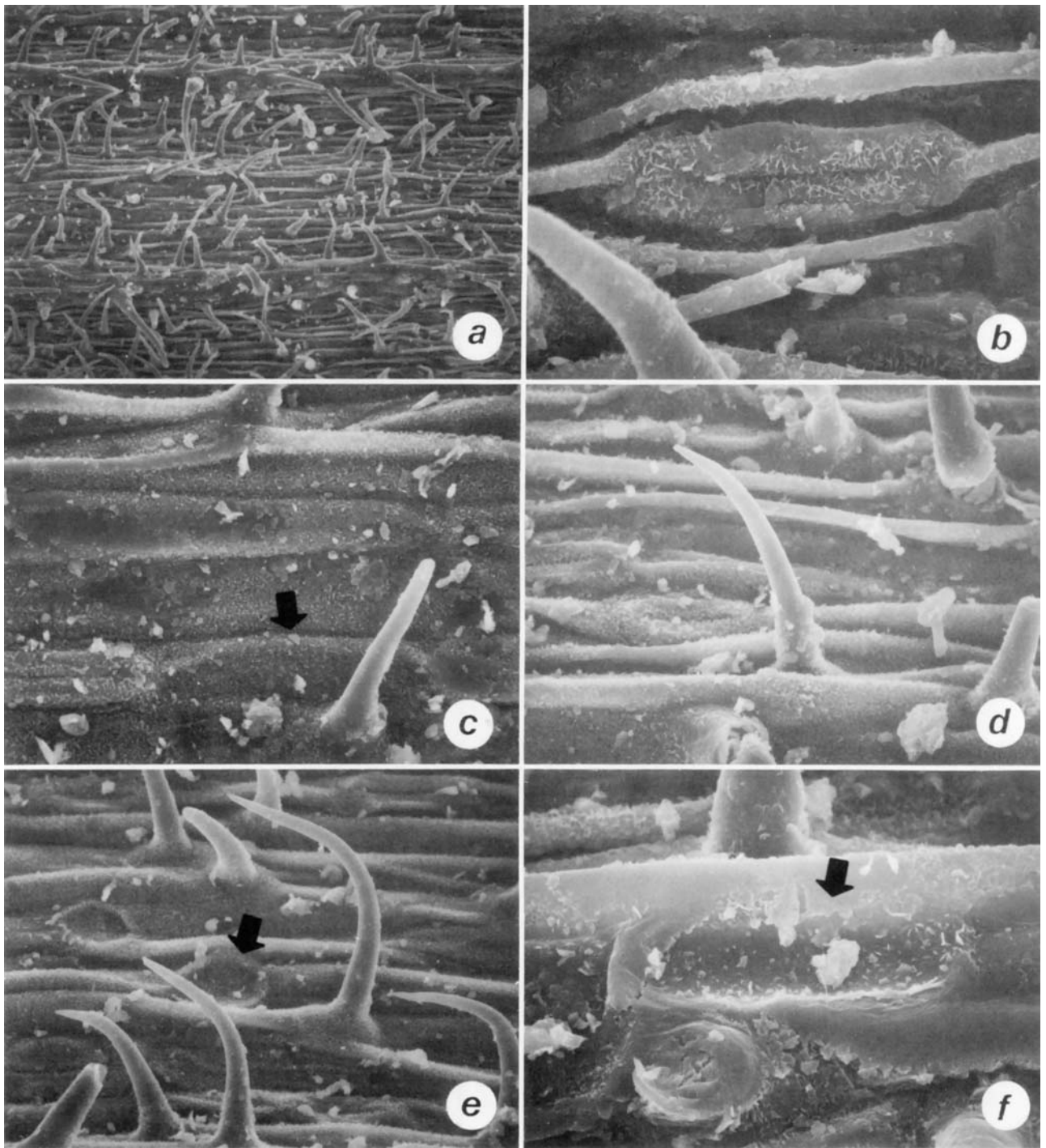


PLATE 21.—Abaxial epidermis *Hordeum marinum*, Bornmütter 11102: *a*, overview, $\times 161$; *b*, stoma, $\times 1696$; *c*, interstomatal cell (arrow), long cells, $\times 867$; *d*, short macrohair-type prickles, $\times 867$; *e*, macrohair, short macrohairs, intercostal silica bodies (arrow), $\times 625$; *f*, costal silica body (arrow), $\times 1696$.

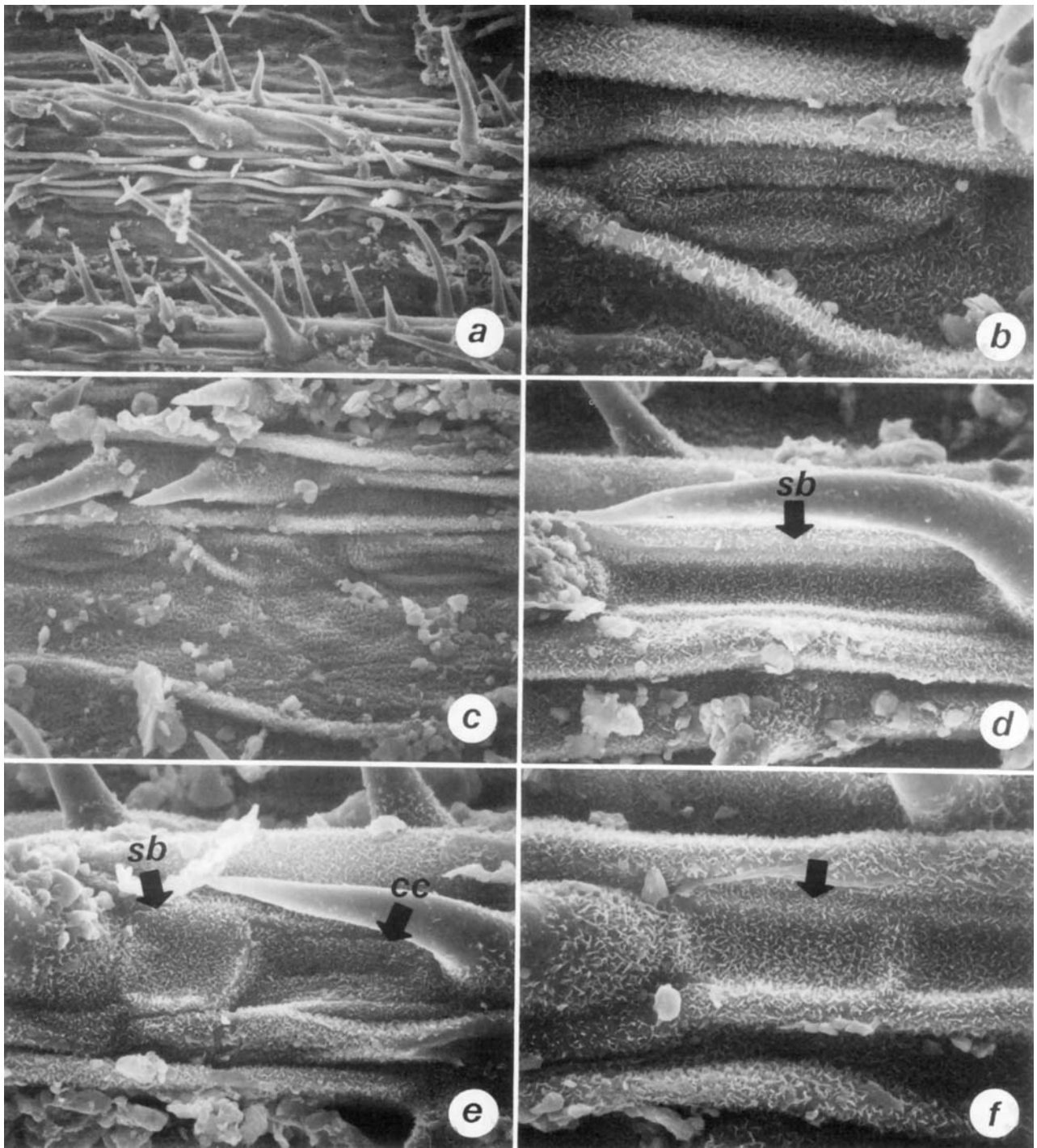


PLATE 22.—Adaxial epidermis *Hordeum marinum*, Bornmütter 11102: *a*, overview, $\times 295$; *b*, stoma, $\times 1696$; *c*, stomata, interstomatal cell, long cells, $\times 867$; *d*, costal silica body (arrow), $\times 1285$; *e*, costal silica body (sb) and cork cell (cc), $\times 1285$; *f*, costal silica body (arrow), $\times 1696$.

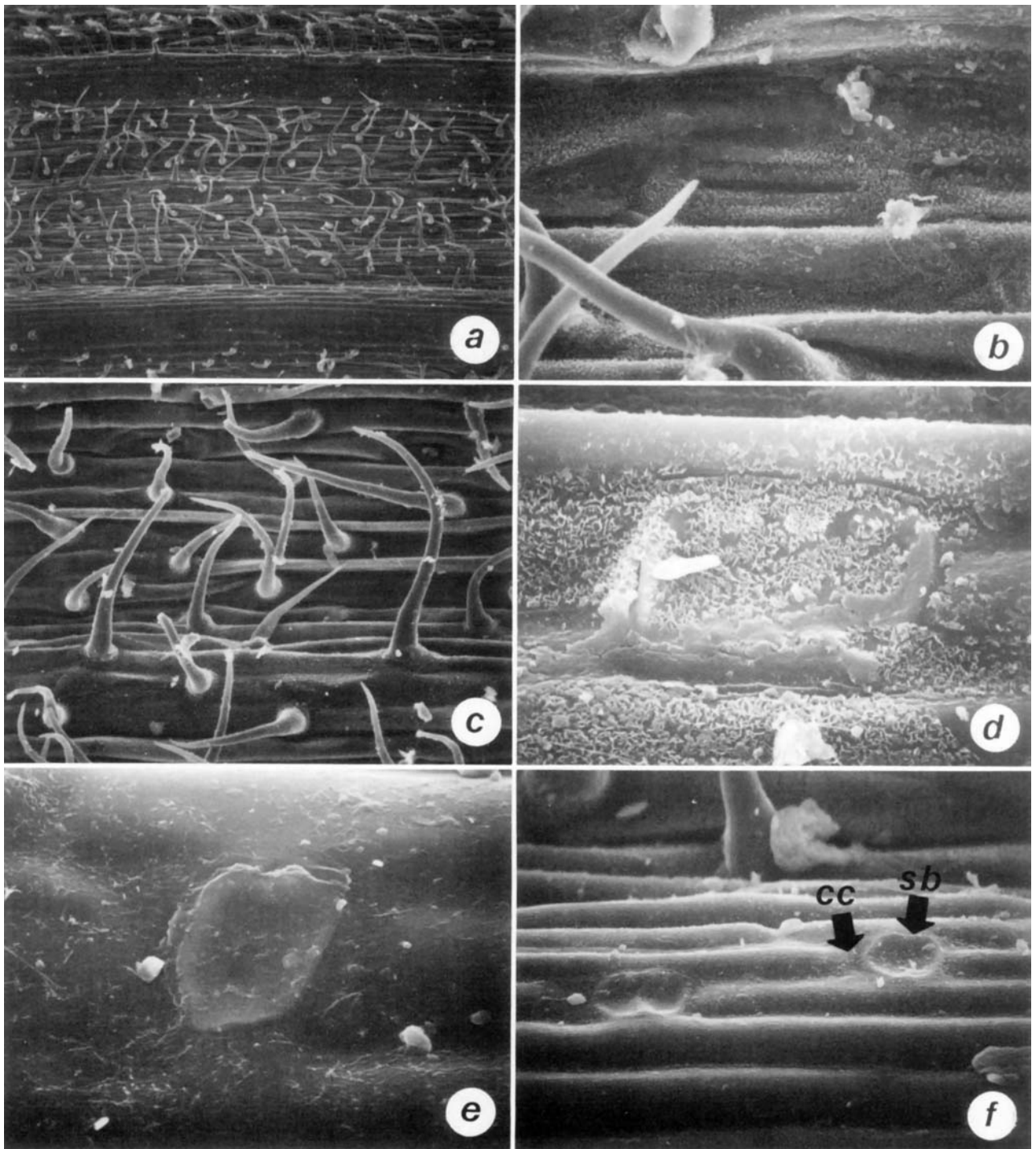


PLATE 23.—Abaxial epidermis *Secale africanum*, Schweickerdt 7482: *a*, overview, $\times 80$; *b*, stoma, $\times 867$; *c*, long cells, macrohairs, $\times 295$; *d*, costal silica body, $\times 1696$; *e*, costal silica body, $\times 1696$; *f*, costal silica bodies (sb) and cork cells (cc) (?), $\times 867$.

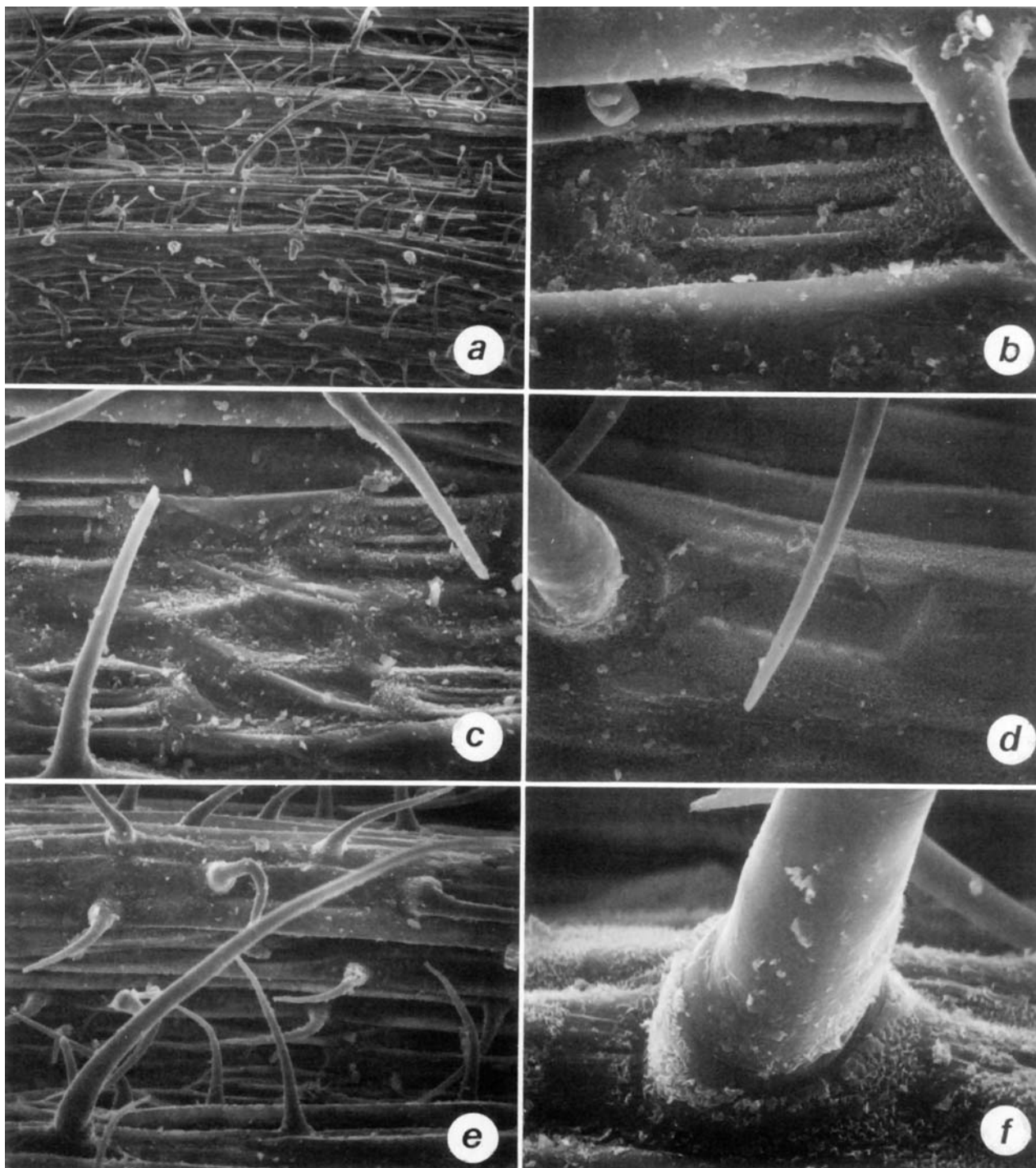


PLATE 24.—Adaxial epidermis *Secale africanum*, Schweickerdt 7482: *a*, overview, $\times 80$; *b*, stoma, $\times 1285$; *c*, interstomatal cells, $\times 625$; *d*, costal silica body, $\times 867$; *e*, macrohairs, $\times 295$; *f*, base of macrohair, $\times 1696$.

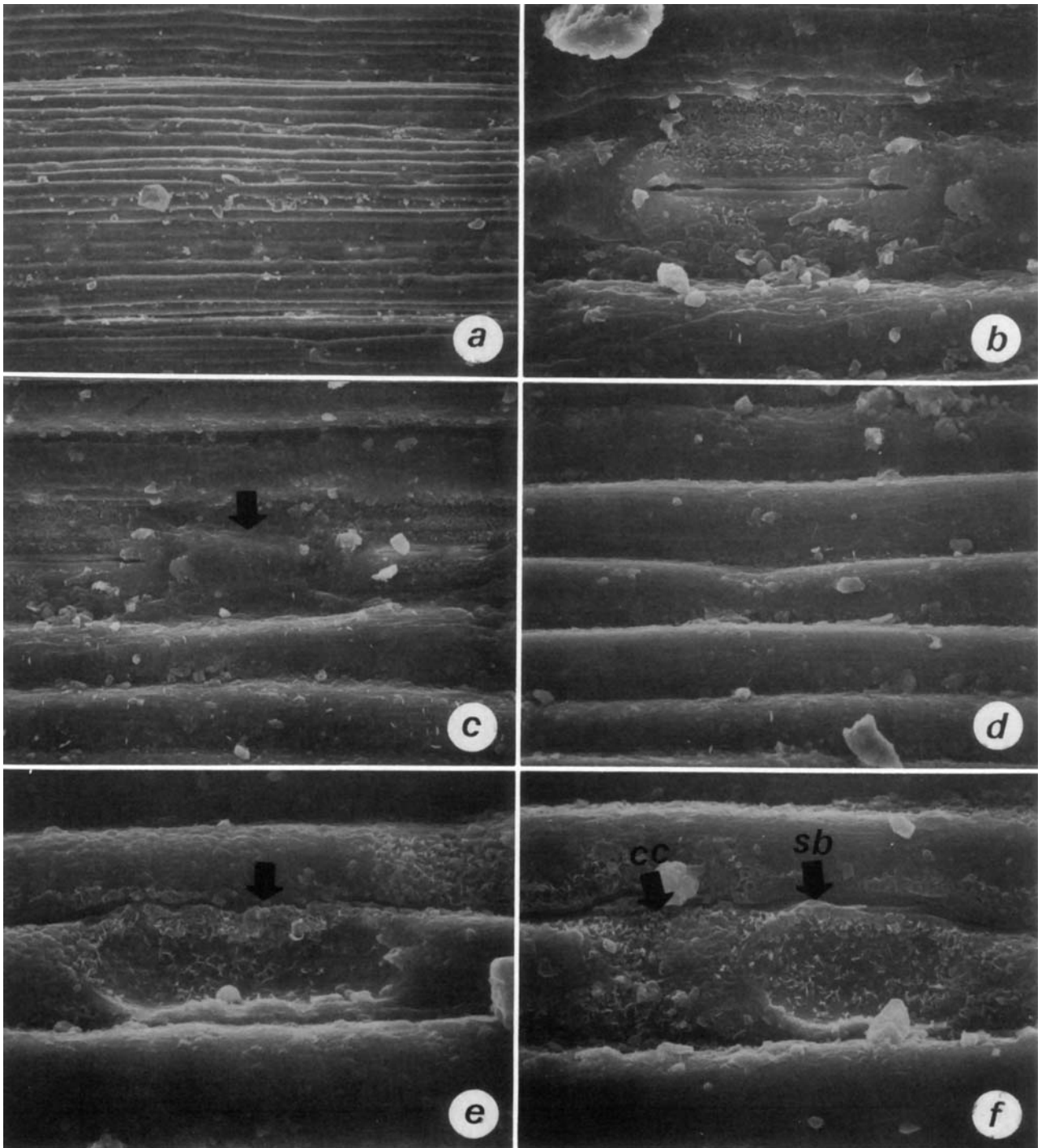


PLATE 25.—Abaxial epidermis *Triticum aestivum*, Harshberger 1139: *a*, overview, $\times 161$; *b*, stoma, $\times 1285$; *c*, interstomatal cell (arrow), $\times 867$; *d*, long cells, $\times 867$; *e*, costal silica body (arrow), $\times 1696$; *f*, costal silica body (sb) and cork cell (cc) (?), $\times 1696$.

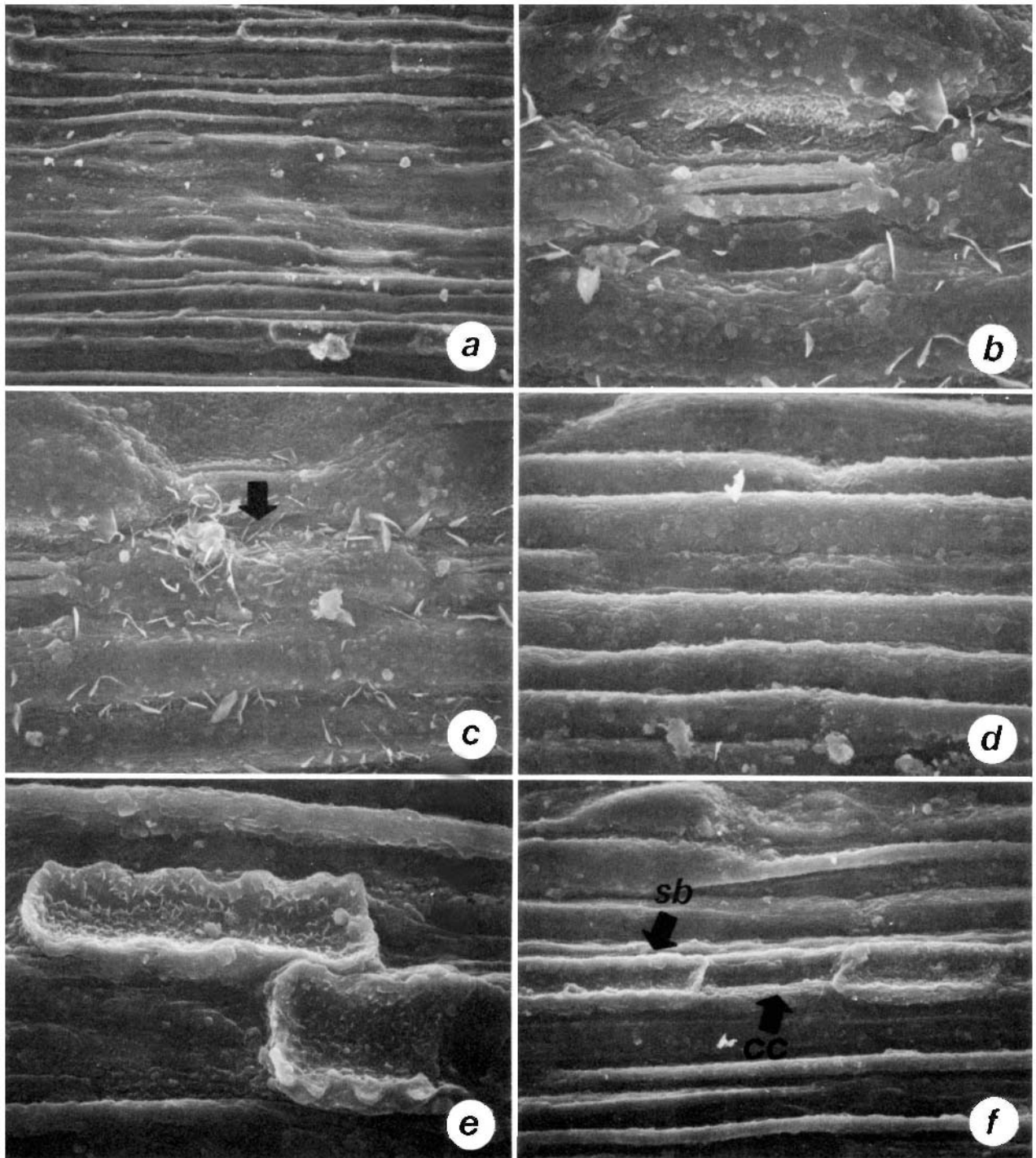


PLATE 26.—Adaxial epidermis *Triticum aestivum*, Harshberger 1139: *a*, overview, $\times 295$; *b*, stoma, $\times 1285$; *c*, interstomatal cell, (arrow), $\times 867$; *d*, long cells, $\times 867$; *e*, costal silica bodies, $\times 1285$; *f*, costal silica bodies (*sb*) and cork cells (*cc*) (?), $\times 625$.

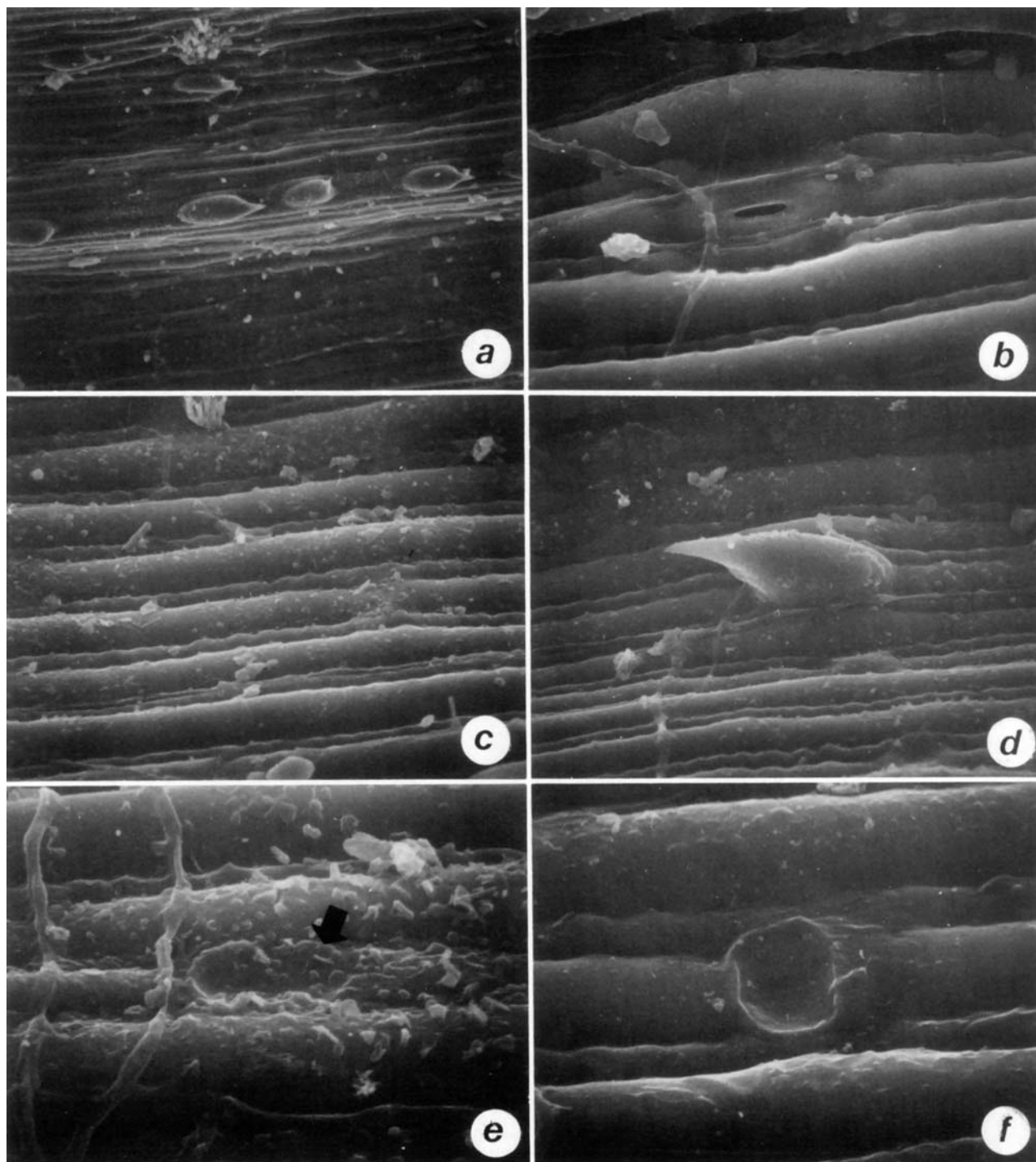


PLATE 27.—Abaxial epidermis *Streblochaete longiarista*, Brenan 9512: *a*, overview, $\times 295$; *b*, stoma, $\times 1696$; *c*, long cells, $\times 1285$; *d*, intercostal prickle, $\times 1285$; *e*, costal silica body (arrow), $\times 2970$; *f*, intercostal silica body, $\times 2970$.

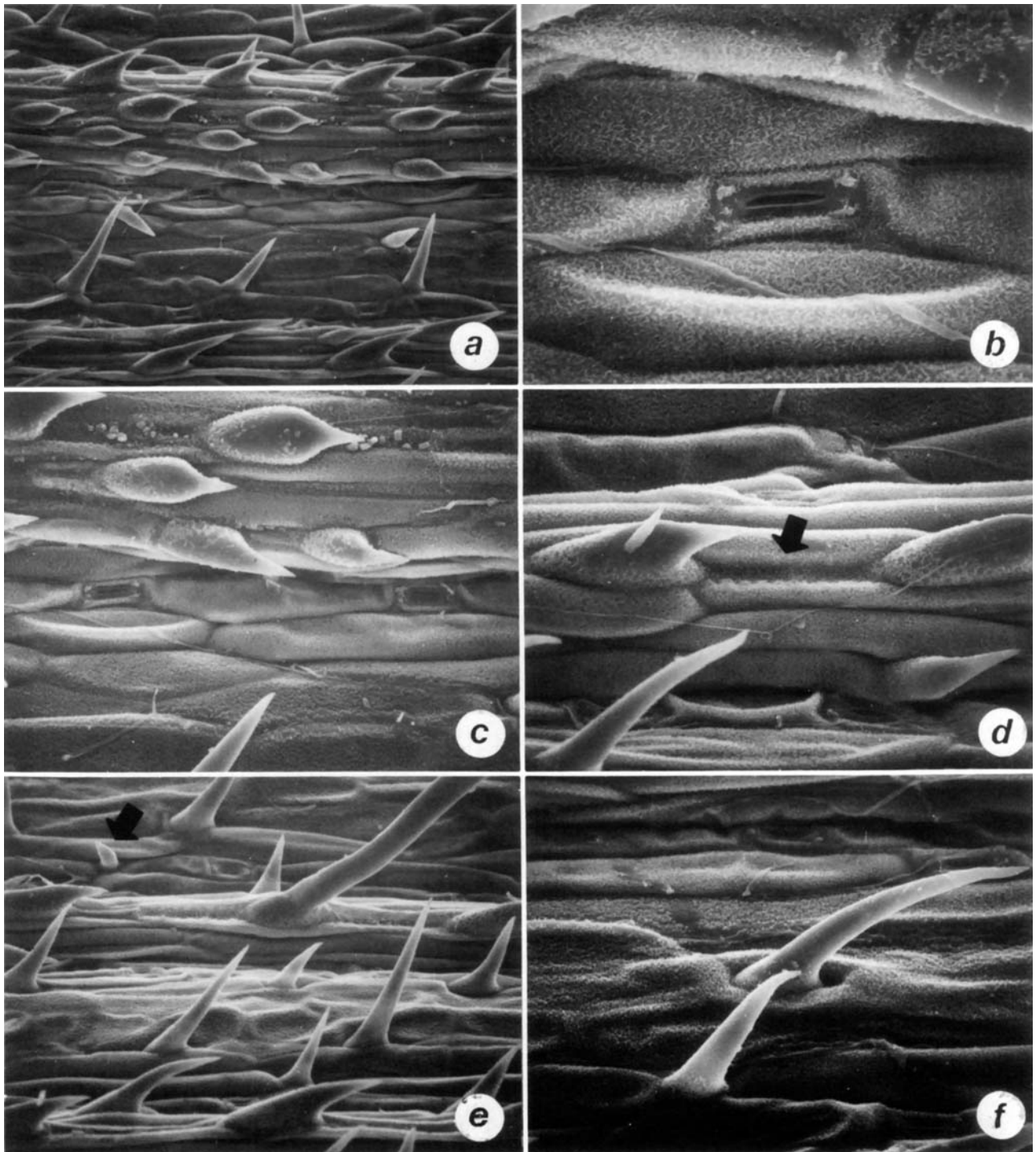


PLATE 28.—Adaxial epidermis *Streblochaete longiarista*, Brenan 9512: *a*, overview, $\times 295$; *b*, stoma, $\times 1696$; *c*, interstomatal cell, $\times 625$; *d*, costal prickles and silica body (arrow), $\times 867$; *e*, macrohair, prickles, and hooks (arrow), $\times 416$; *f*, short macrohair-type prickle with sunken base, $\times 867$.

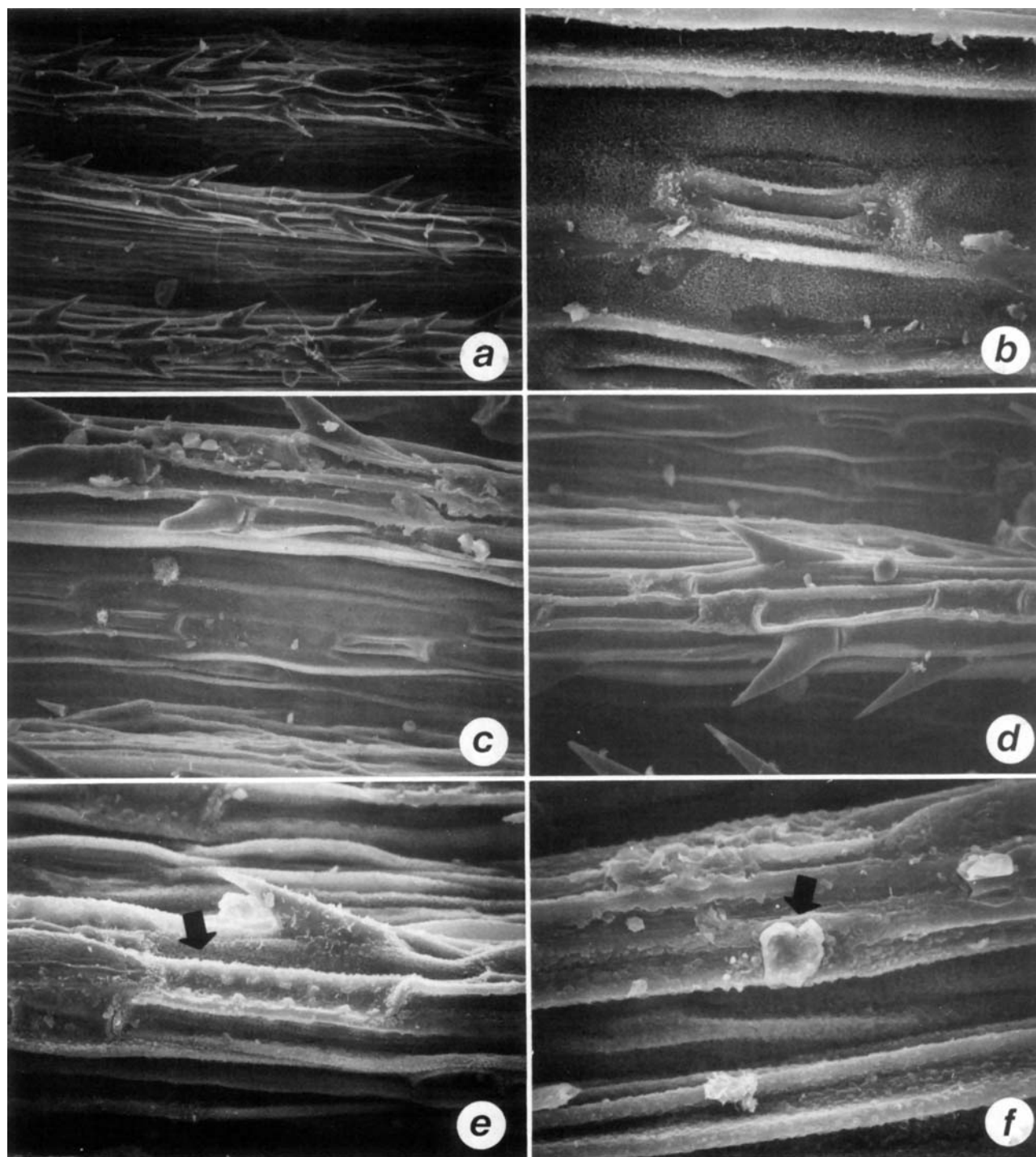


PLATE 29.—Abaxial epidermis *Aira caryophyllea*, Morton 7069: *a*, overview, $\times 161$; *b*, stoma, $\times 1285$; *c*, interstomatal cell, $\times 416$; *d*, costal prickles and short cells, $\times 416$; *e*, costal silica body (arrow), $\times 625$; *f*, costal silica body (arrow), $\times 867$.

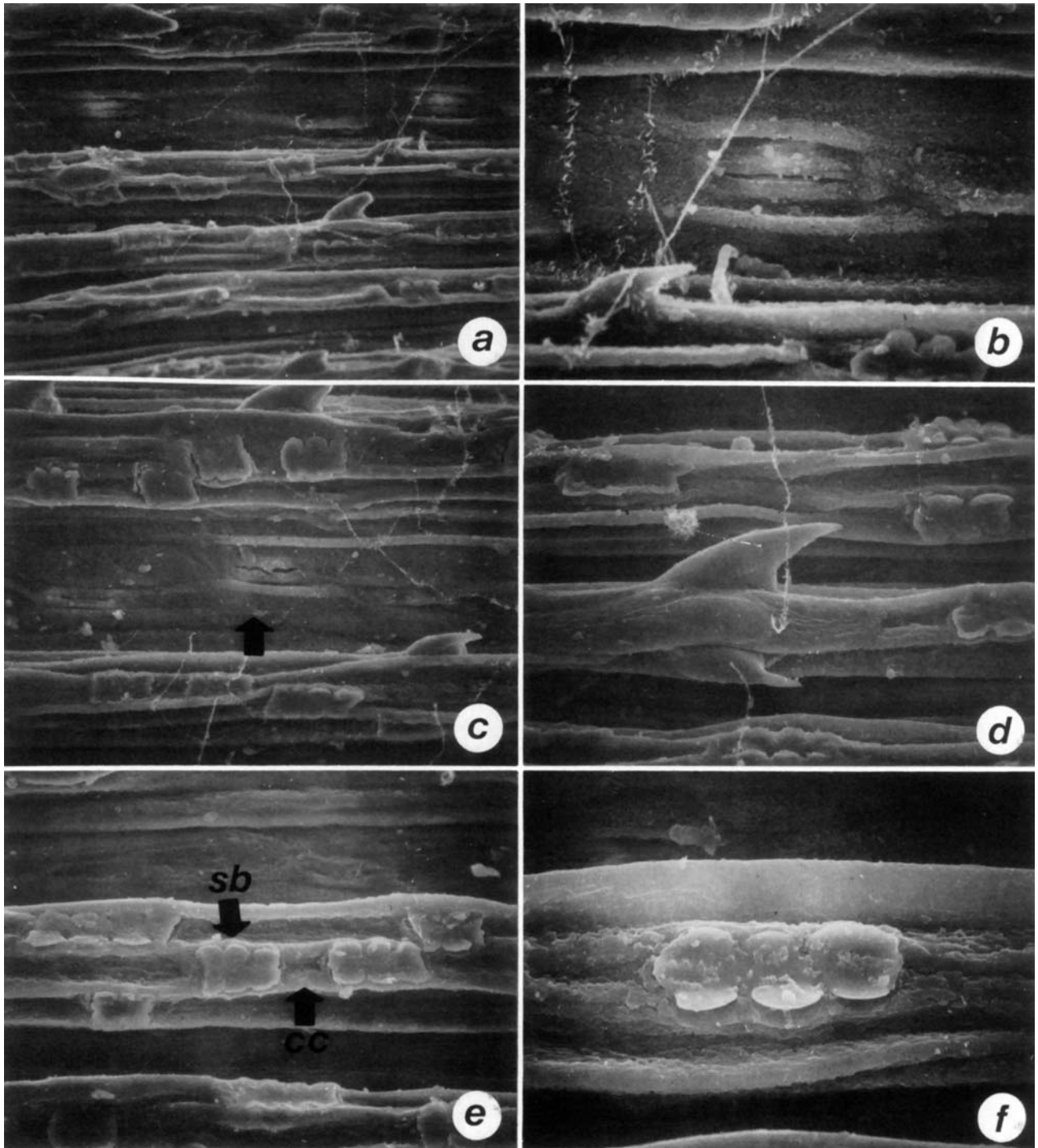


PLATE 30.—Adaxial epidermis *Aira caryophyllea*, Morton 7069: *a*, overview, $\times 295$; *b*, stoma, $\times 867$; *c*, interstomatal cell (arrow), $\times 416$; *d*, costal prickles, $\times 625$; *e*, costal silica bodies (*sb*) and cork cells (*cc*), $\times 625$; *f*, costal silica body, $\times 1285$.

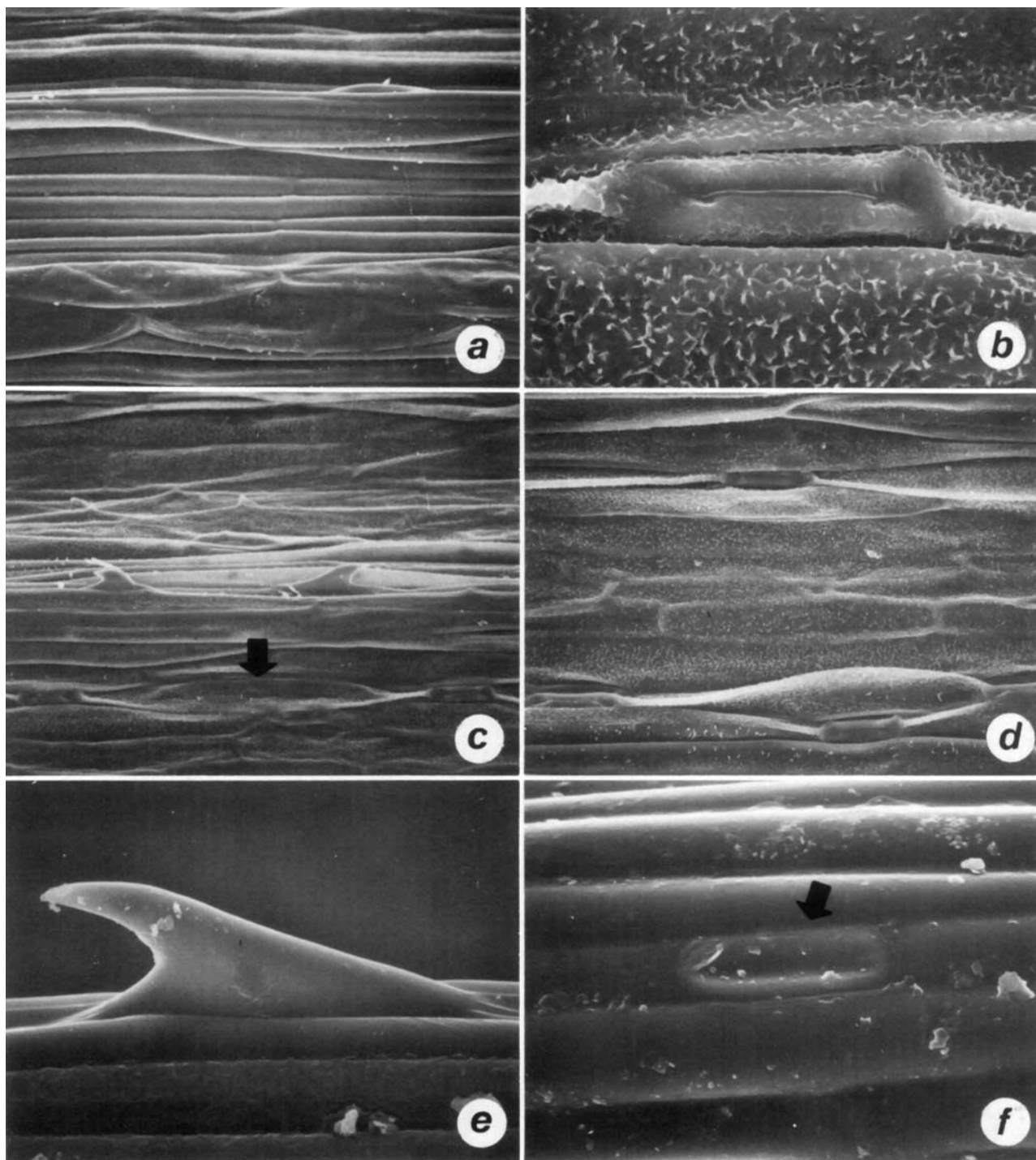


PLATE 31.—Abaxial epidermis *Anthoxanthum nivale*, Amshoff 1970: *a*, overview, $\times 295$; *b*, stoma, $\times 1696$; *c*, interstomatal cell (arrow), $\times 295$; *d*, long cells, $\times 416$; *e*, prickle, $\times 1285$; *f*, silica body (arrow), $\times 1285$.

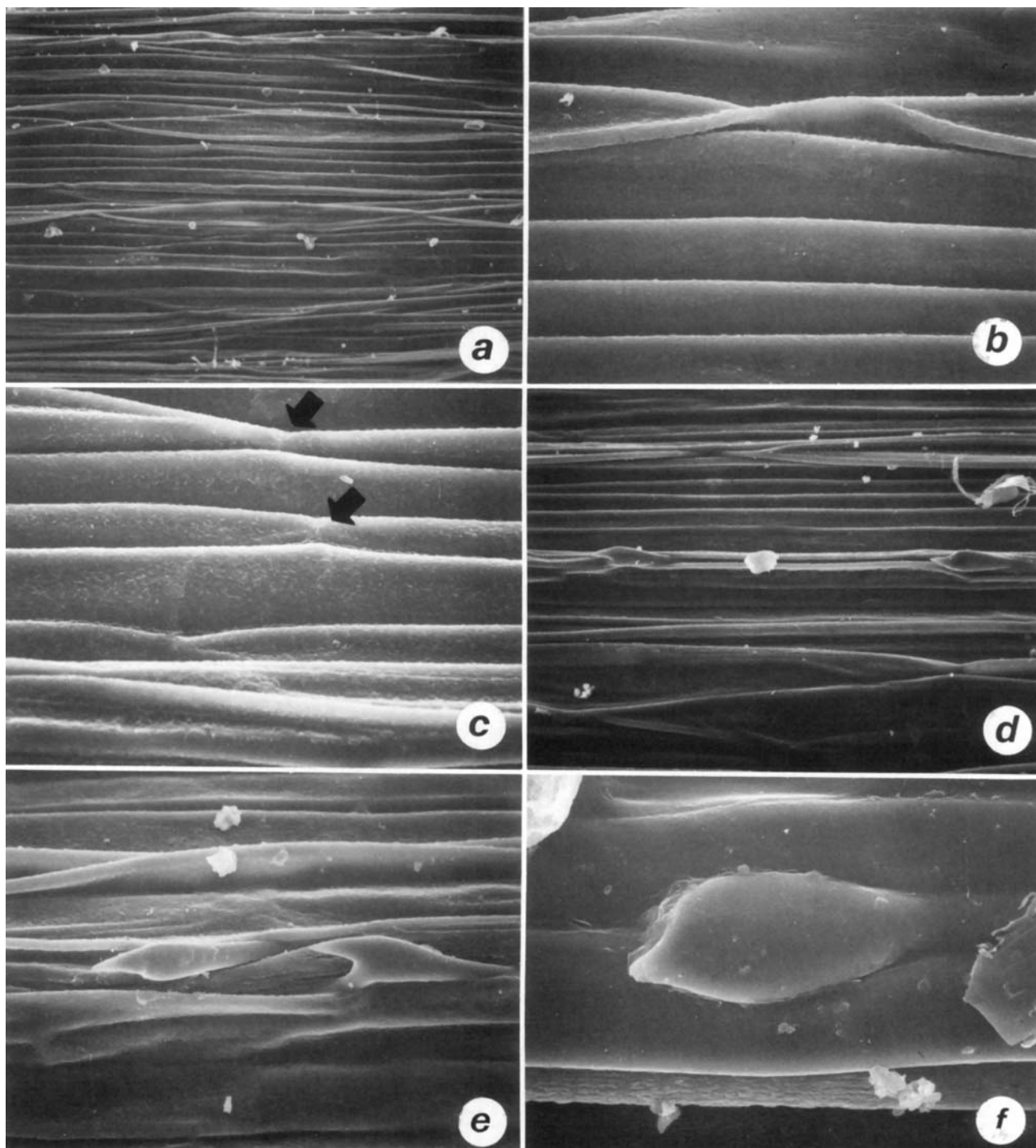


PLATE 32.—Adaxial epidermis *Anthoxanthum nivale*, Amshoff 1970: *a*, overview, $\times 161$; *b*, uniform and nonuniform width long cells, $\times 867$; *c*, end walls (arrows) of long cells, $\times 867$; *d*, prickles and long cells, $\times 295$; *e*, prickles, $\times 625$; *f*, costal prickle, $\times 1285$.

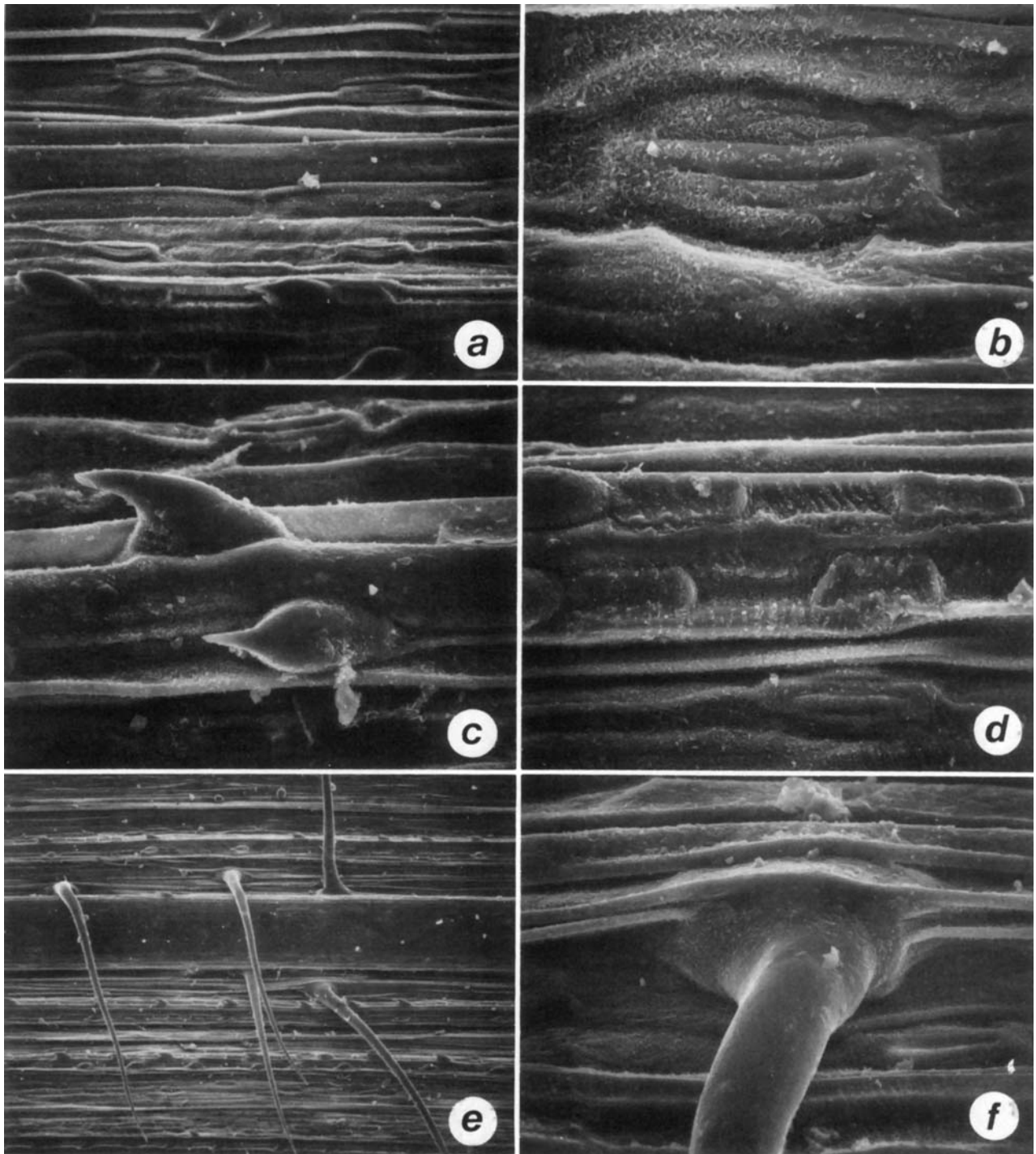


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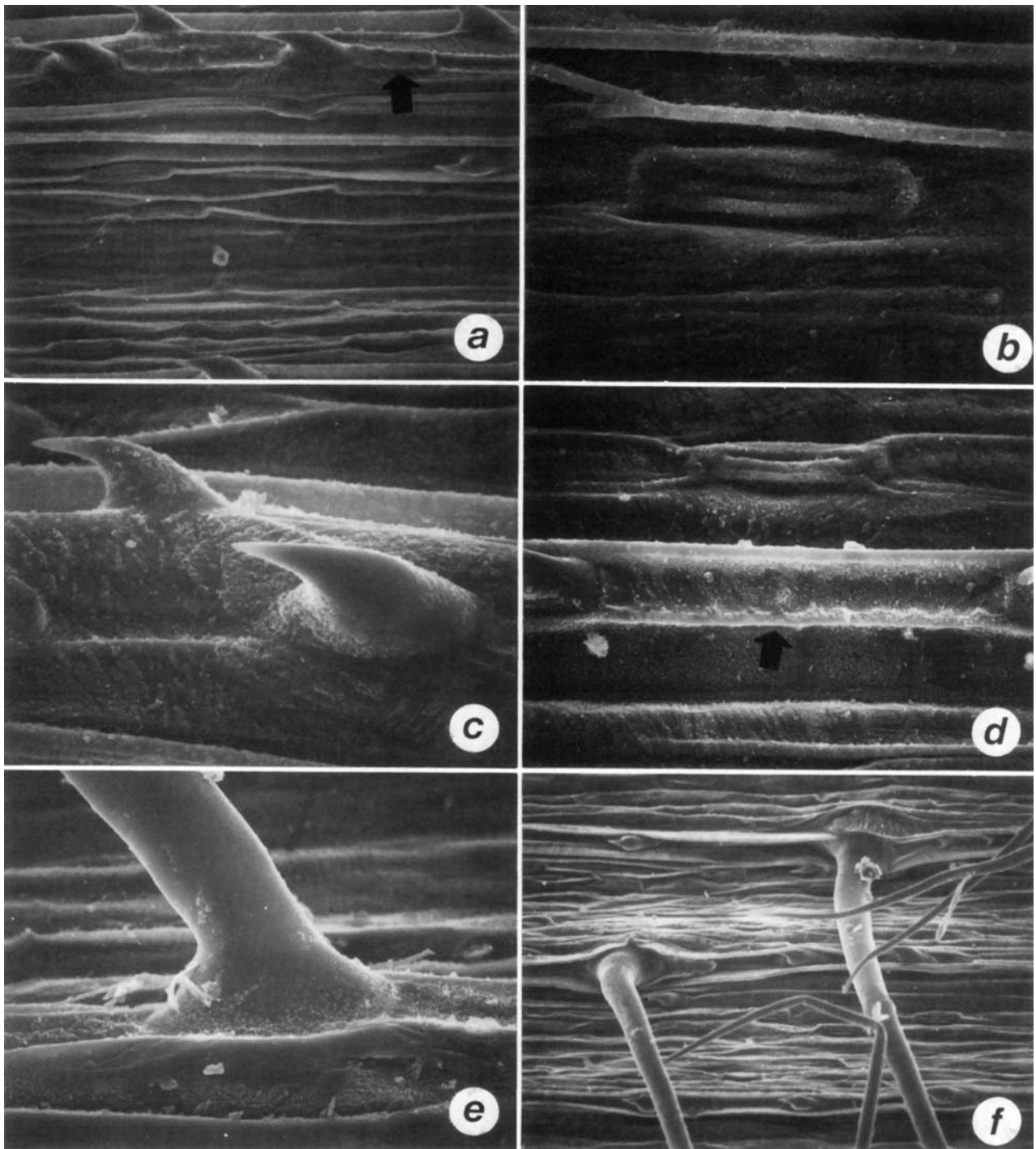


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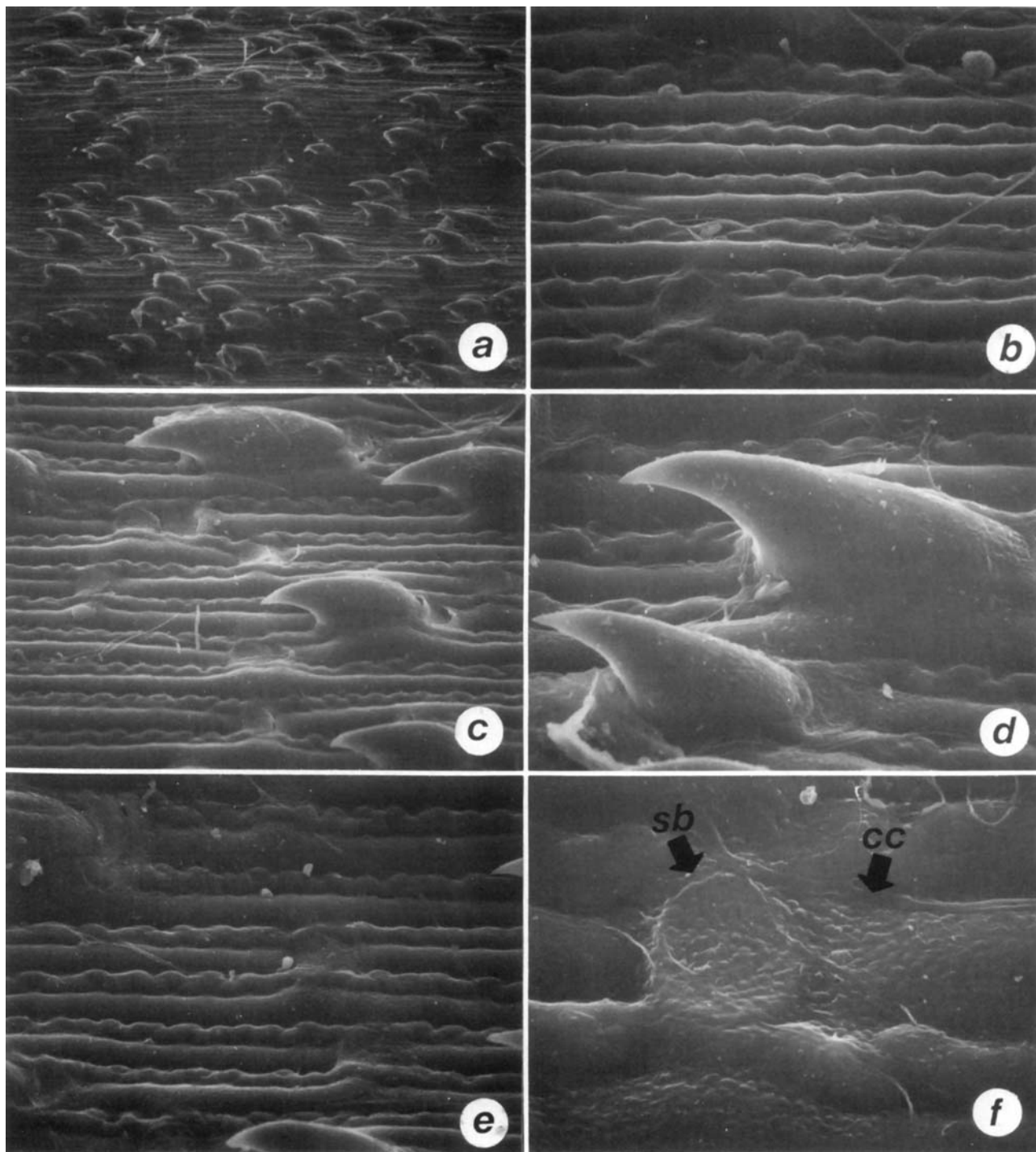


PLATE 35.—Abaxial epidermis *Deschampsia caespitosa* var. *oliveri*, Osmaston 3779: *a*, overview, $\times 161$; *b*, long cells, $\times 1285$; *c*, long cells, short cells, prickles, $\times 625$; *d*, prickles, $\times 1285$; *e*, long cells, short cells, $\times 867$; *f*, silica body (sb), cork cell (cc), $\times 2970$.

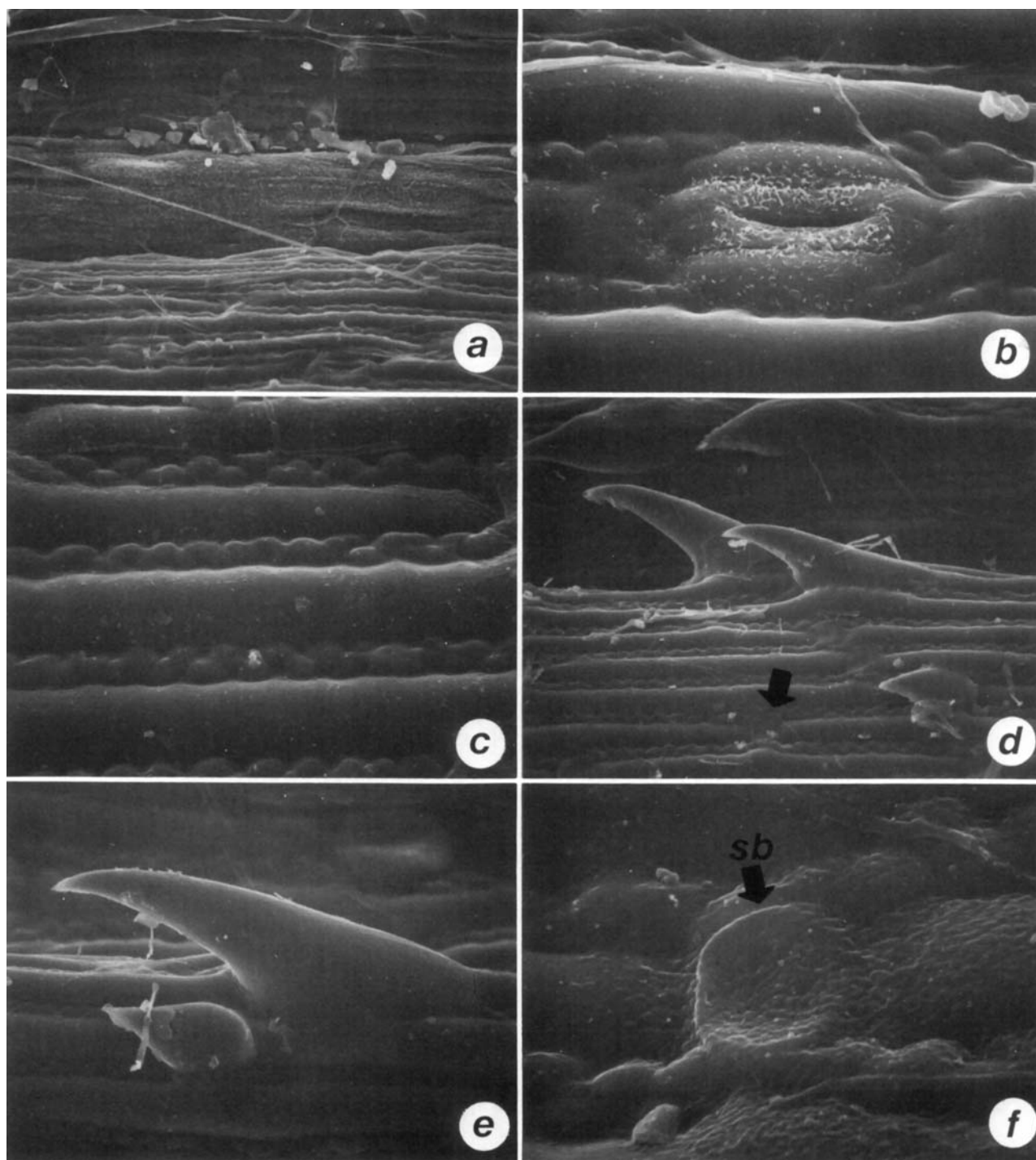


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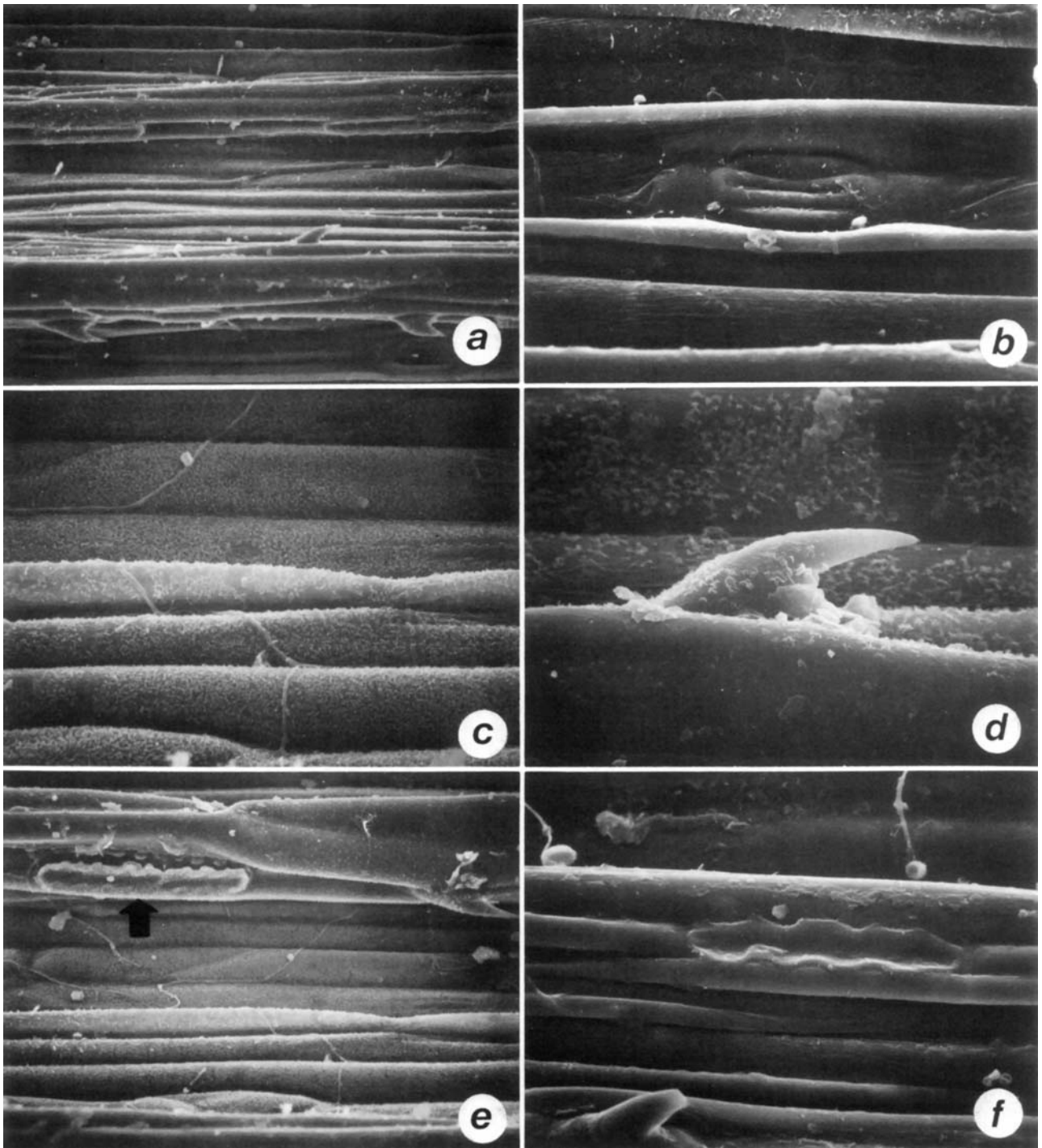


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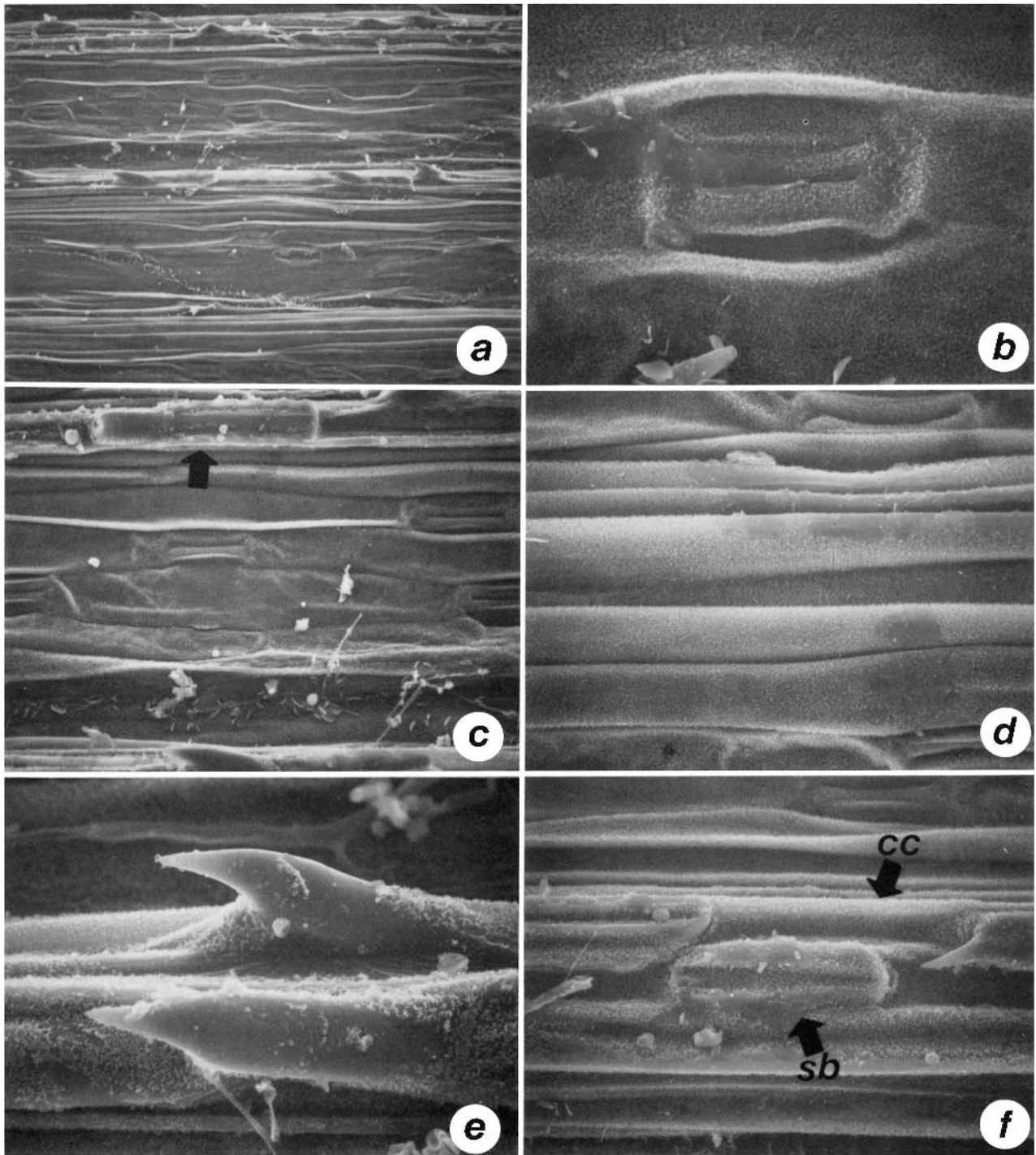


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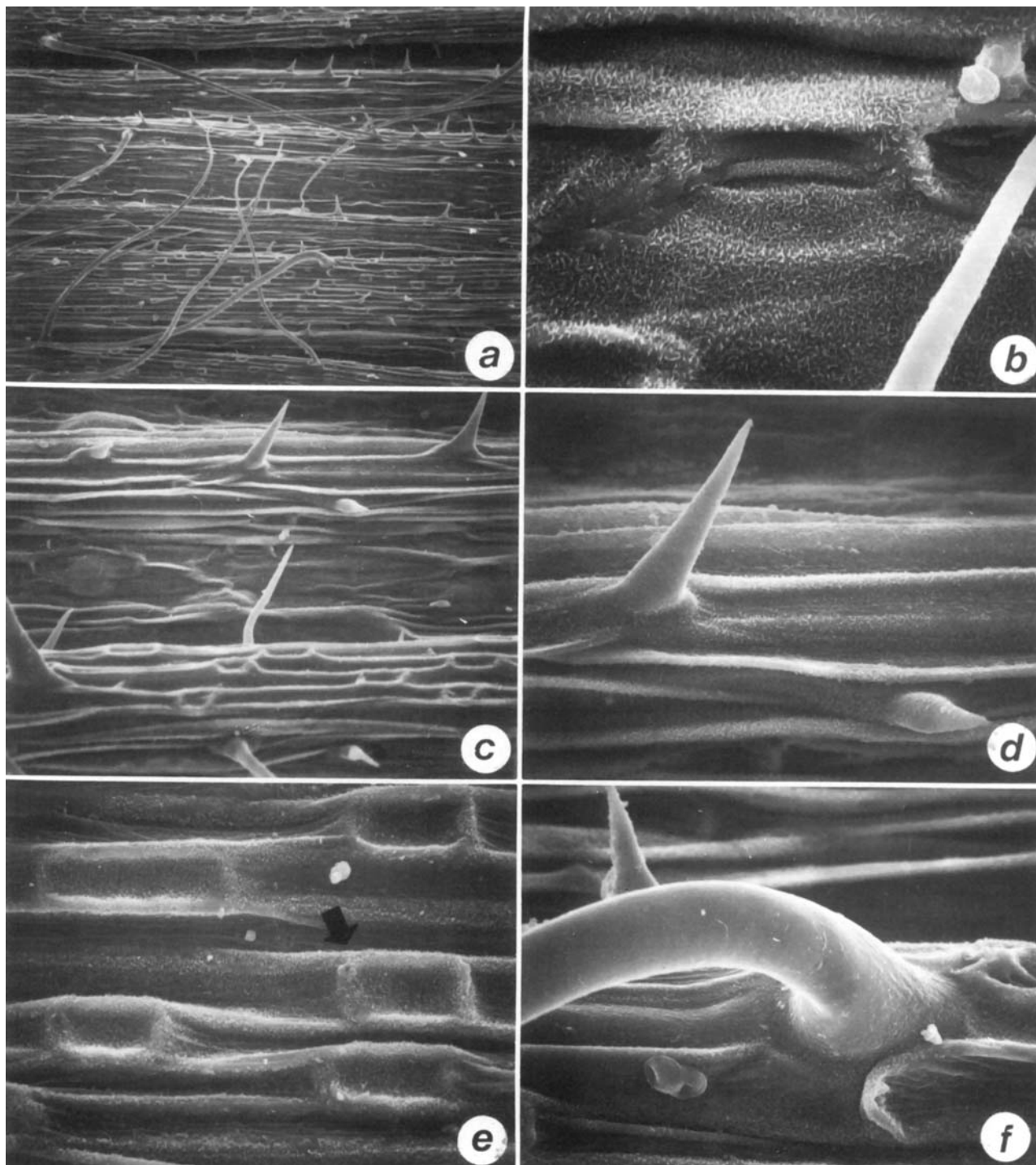


PLATE 39.—Abaxial epidermis *Koeleria capensis*, Taylor 3777: *a*, overview and macrohairs, $\times 80$; *b*, stoma, $\times 1696$; *c*, long cells, $\times 295$; *d*, prickle and short macrohair, $\times 867$; *e*, silica bodies (arrow), $\times 867$; *f*, base of macrohair, $\times 867$.

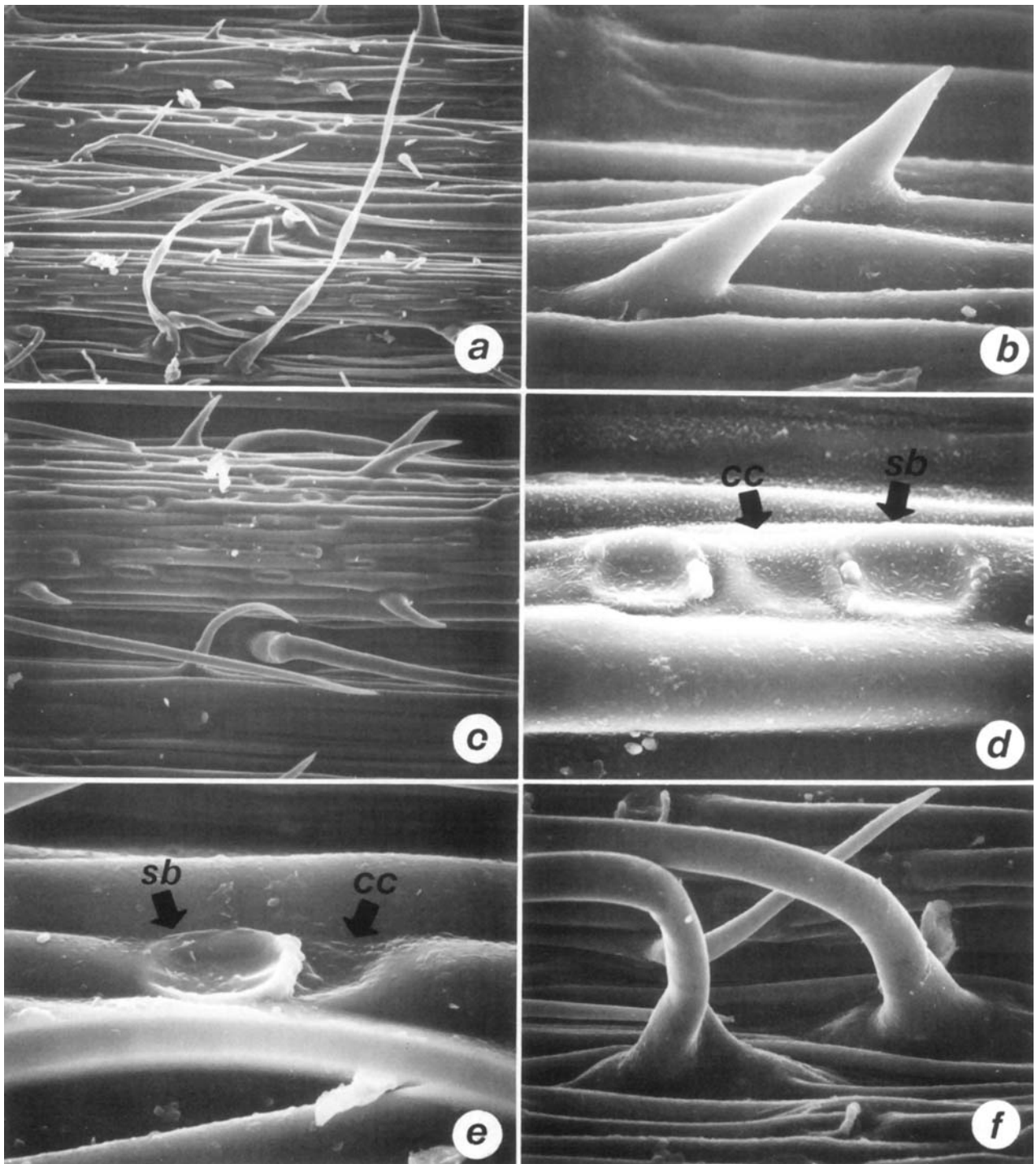


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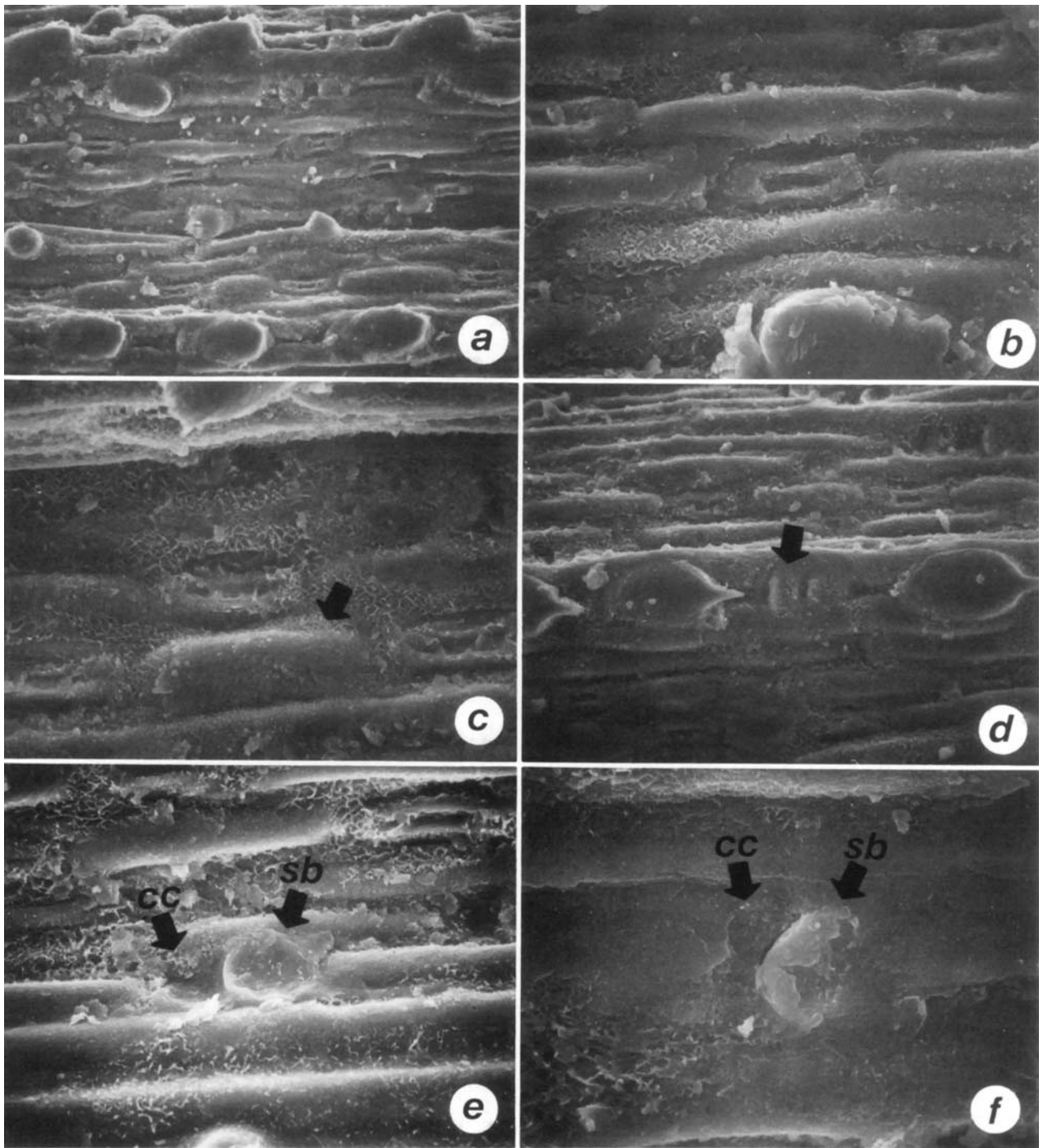


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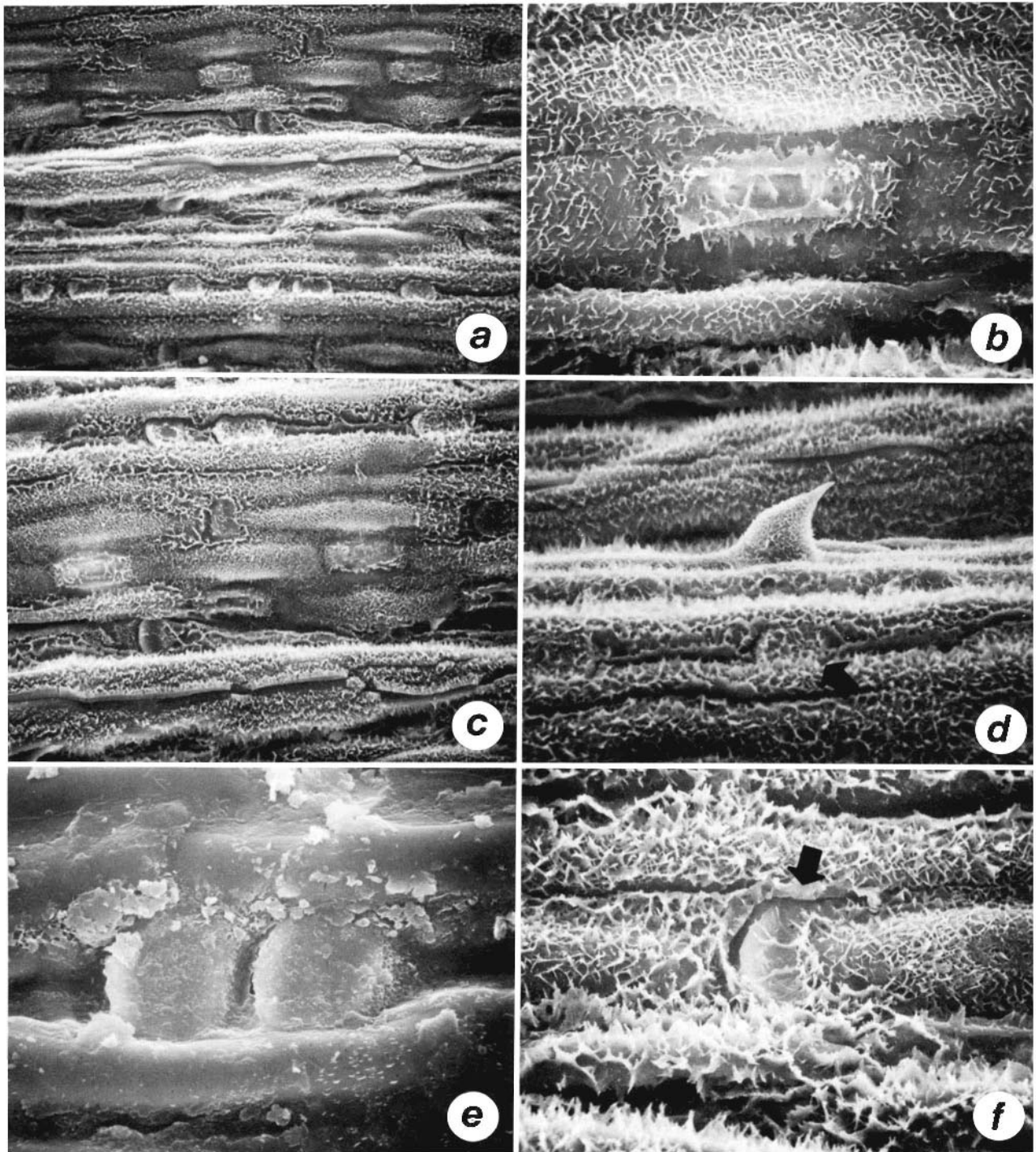


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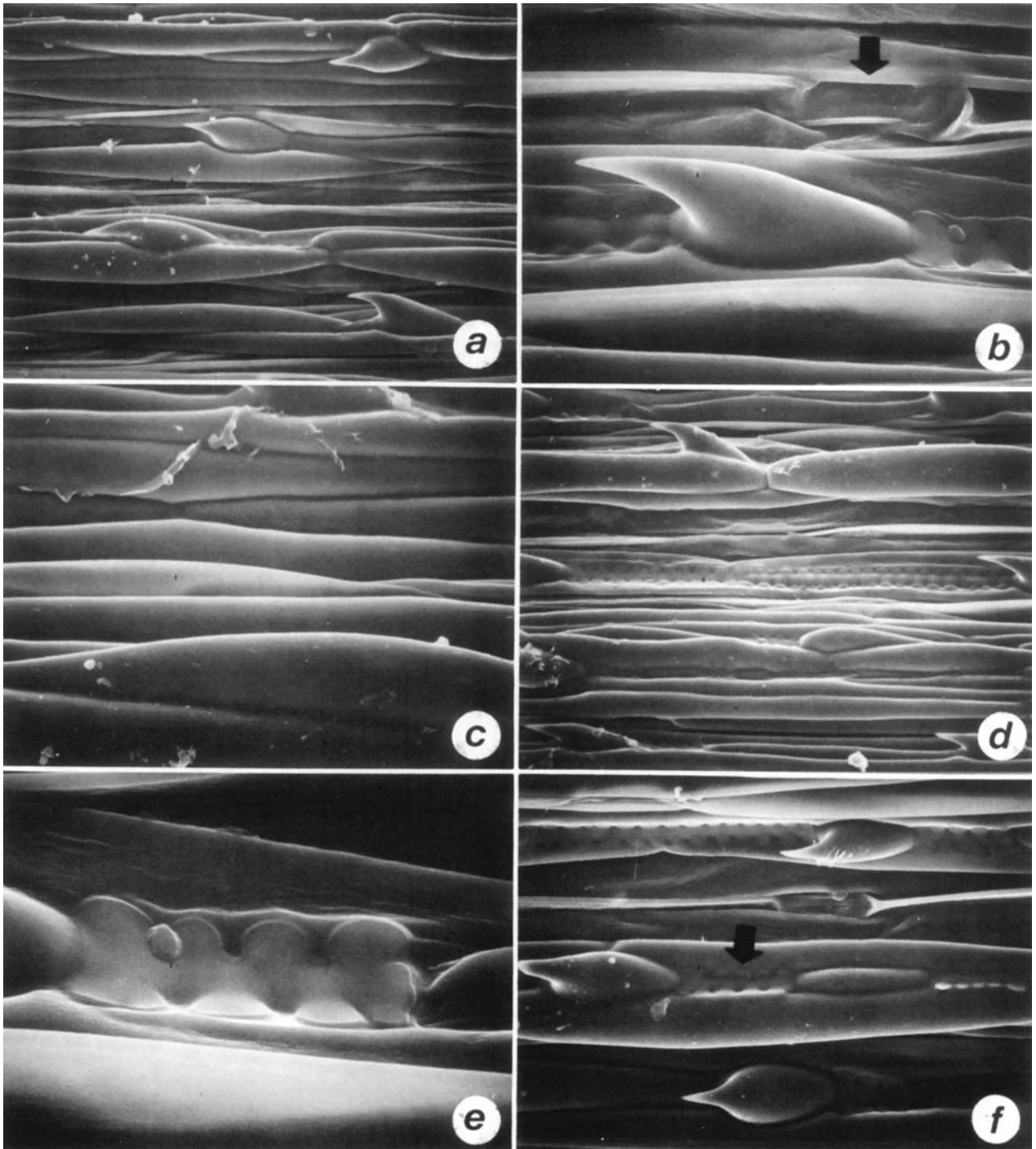


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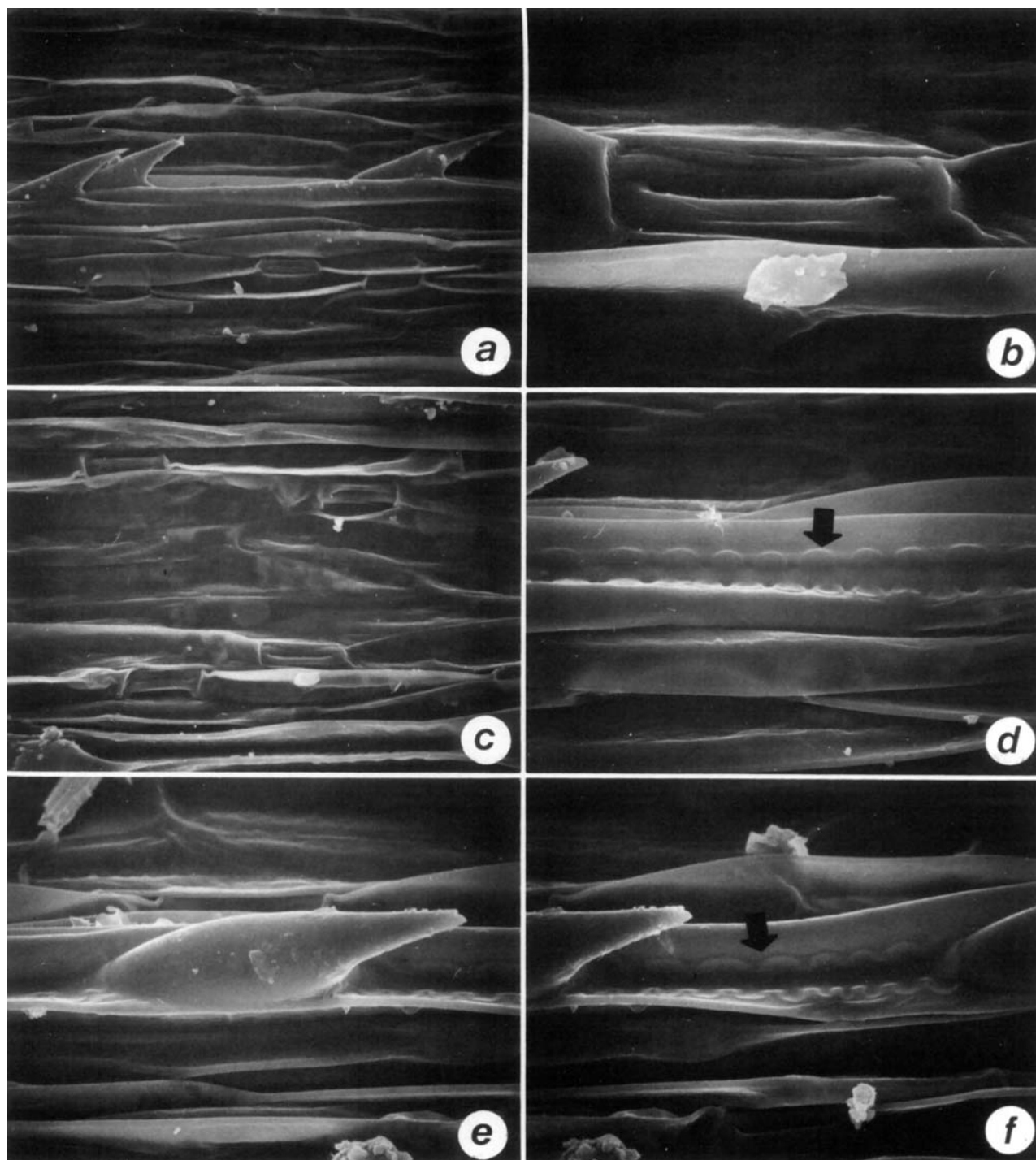


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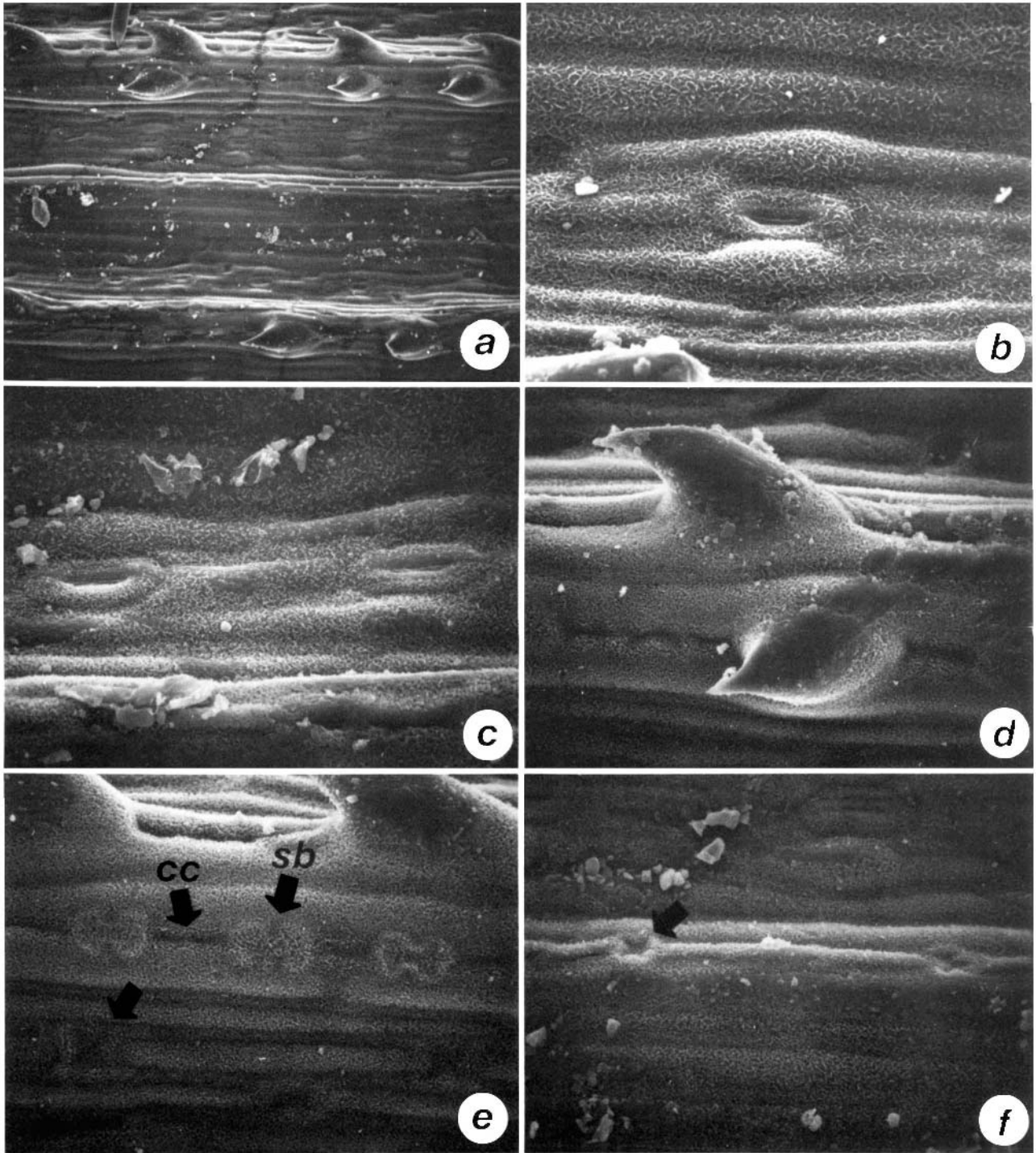


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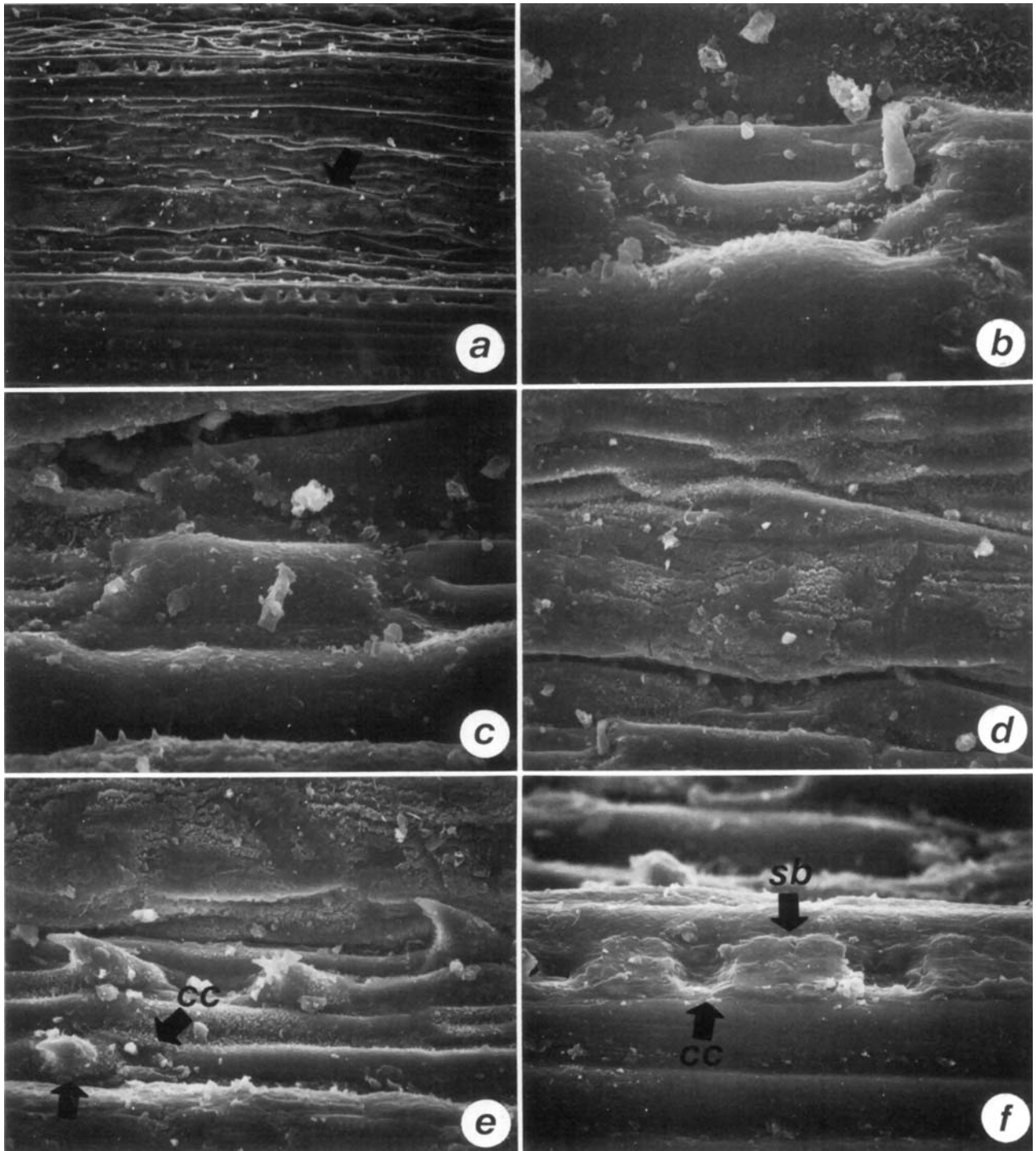


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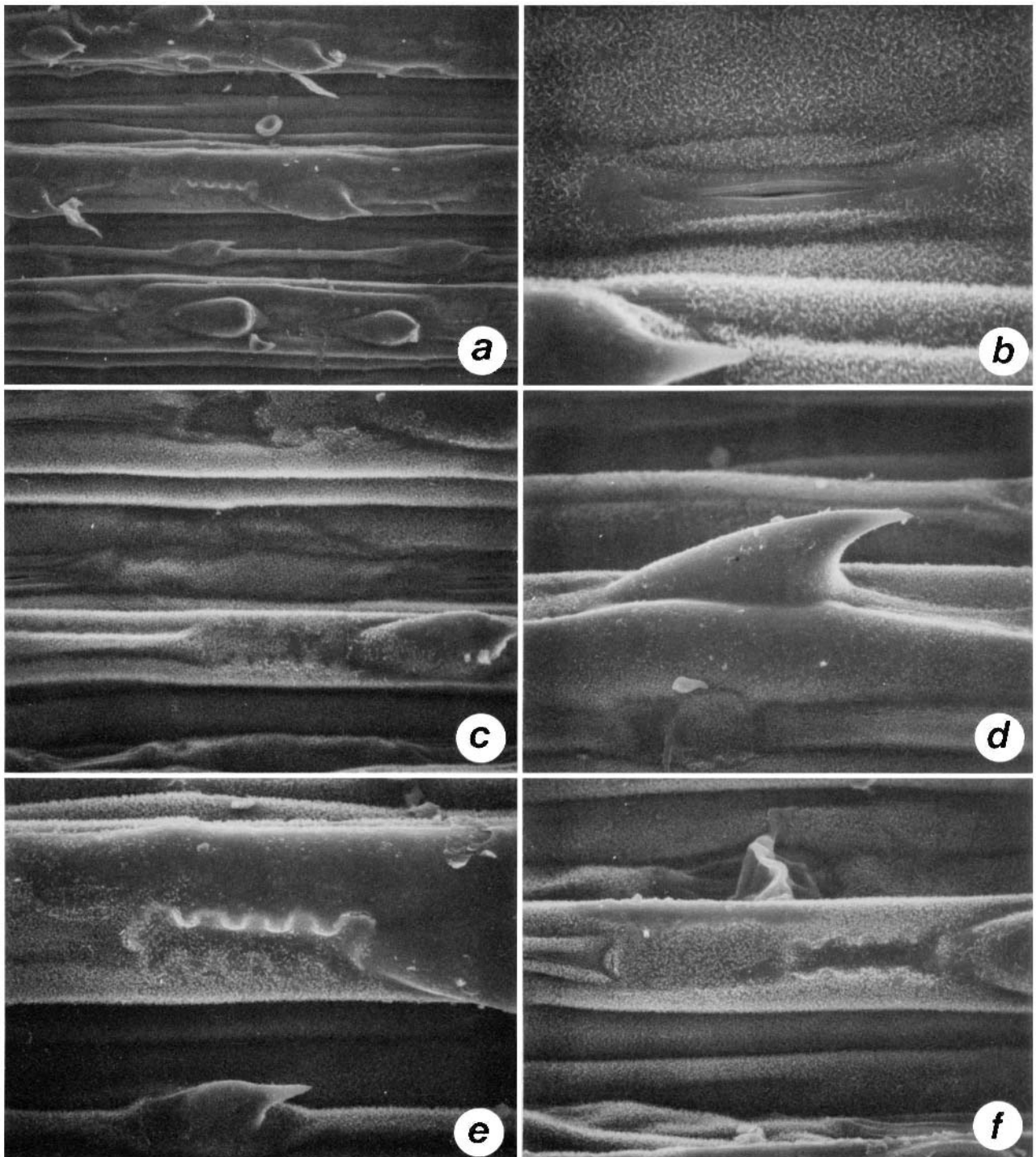


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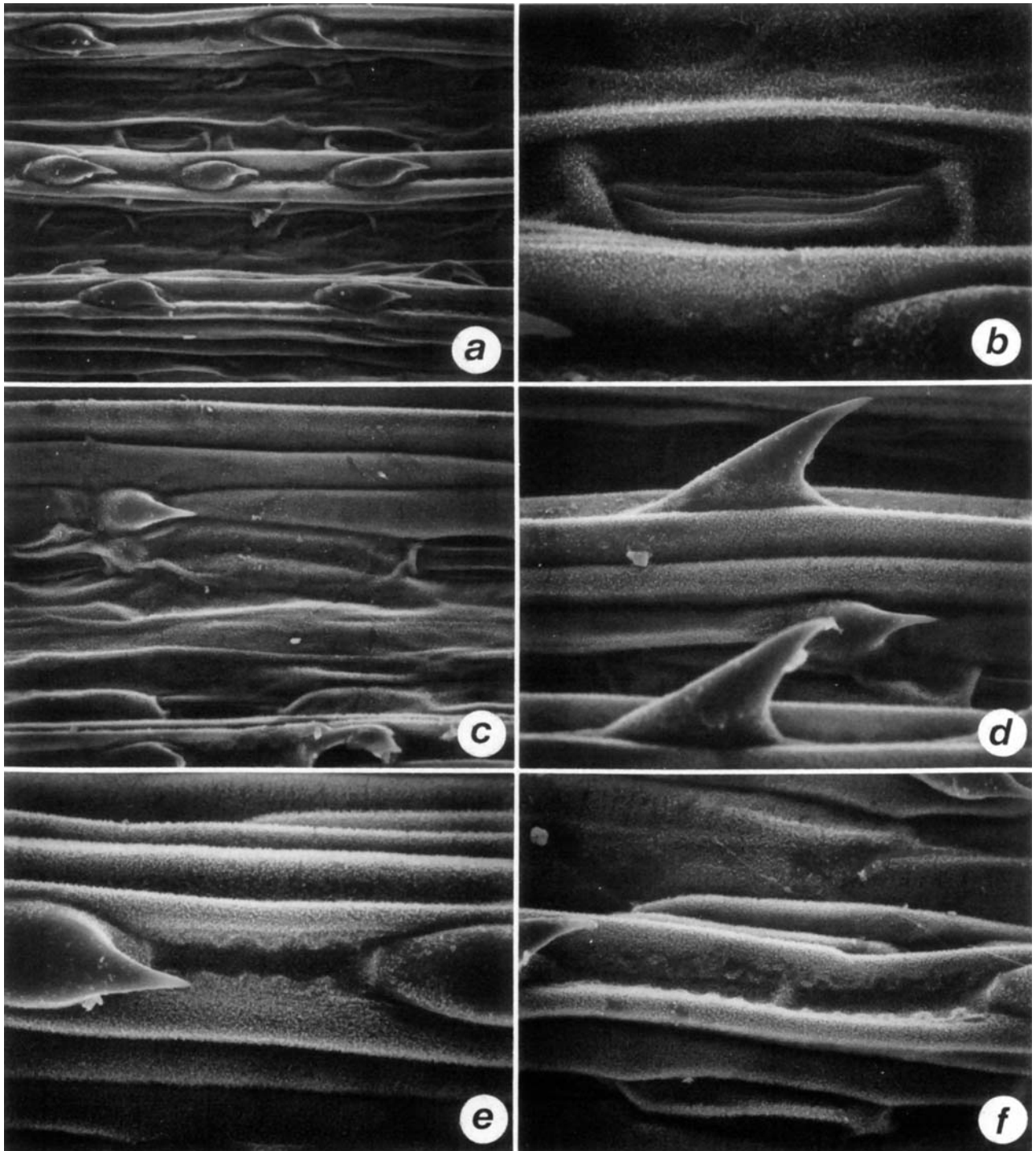


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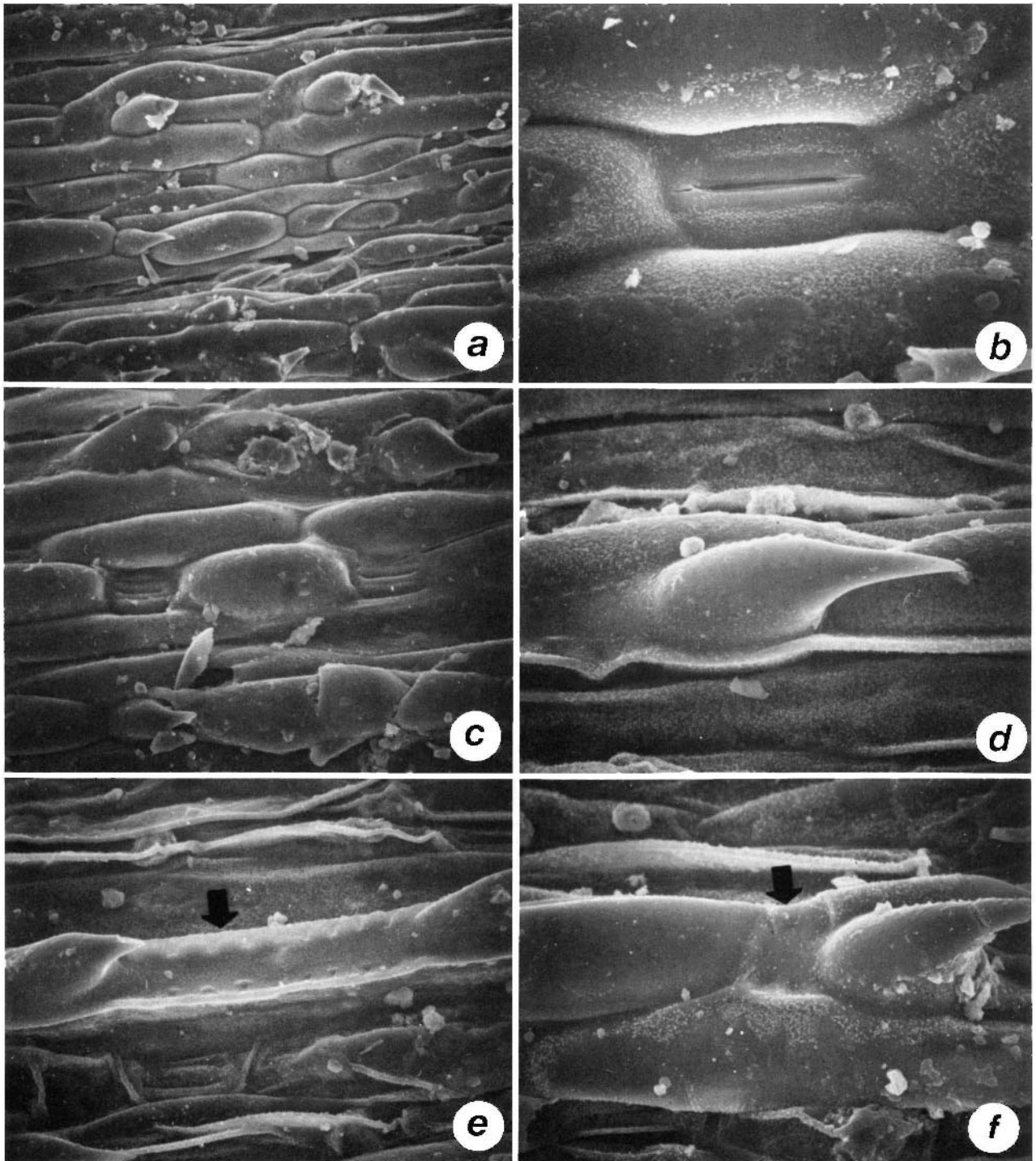


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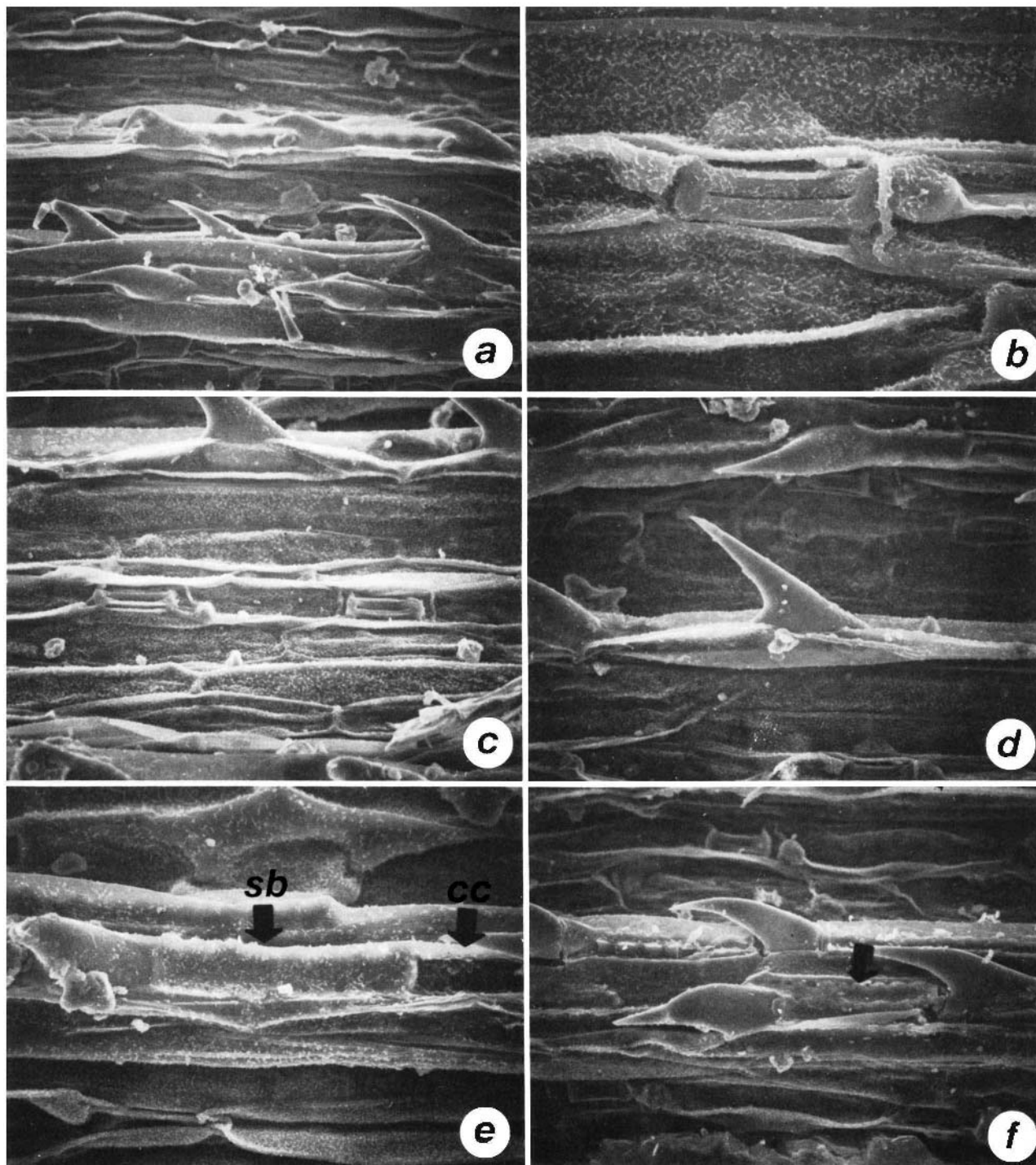


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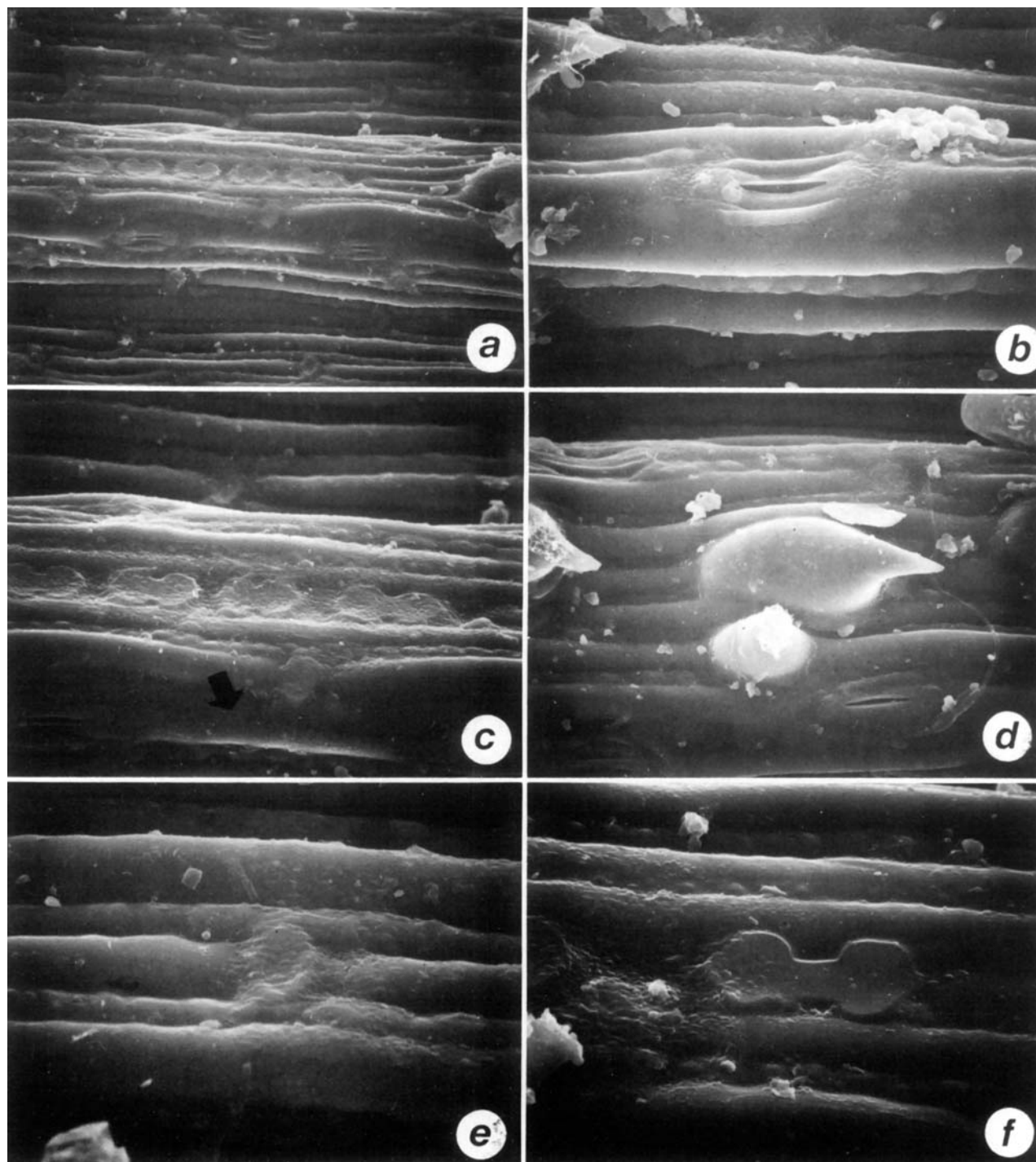


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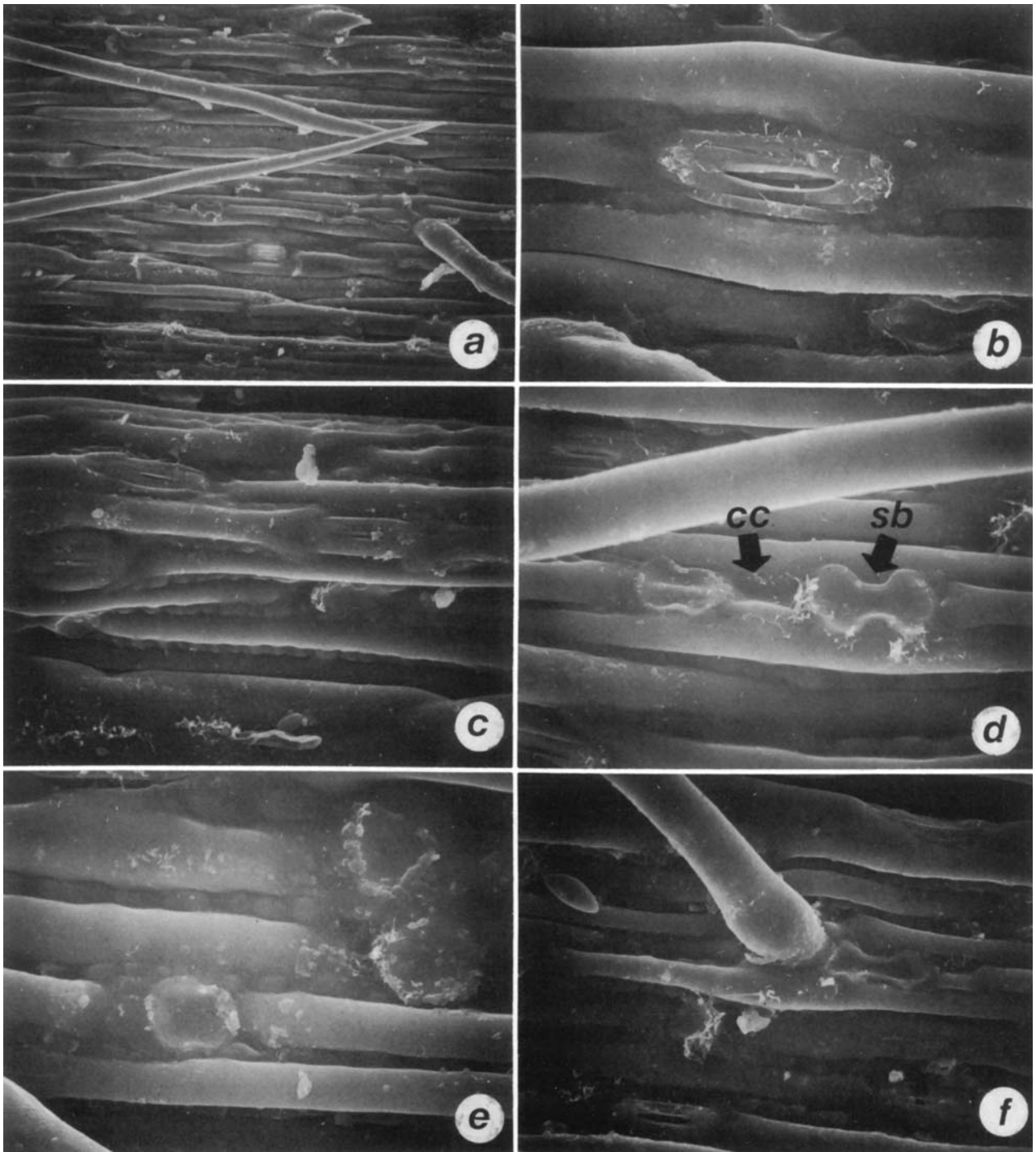


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