Part 8

Echinodermata

Plates 170-175

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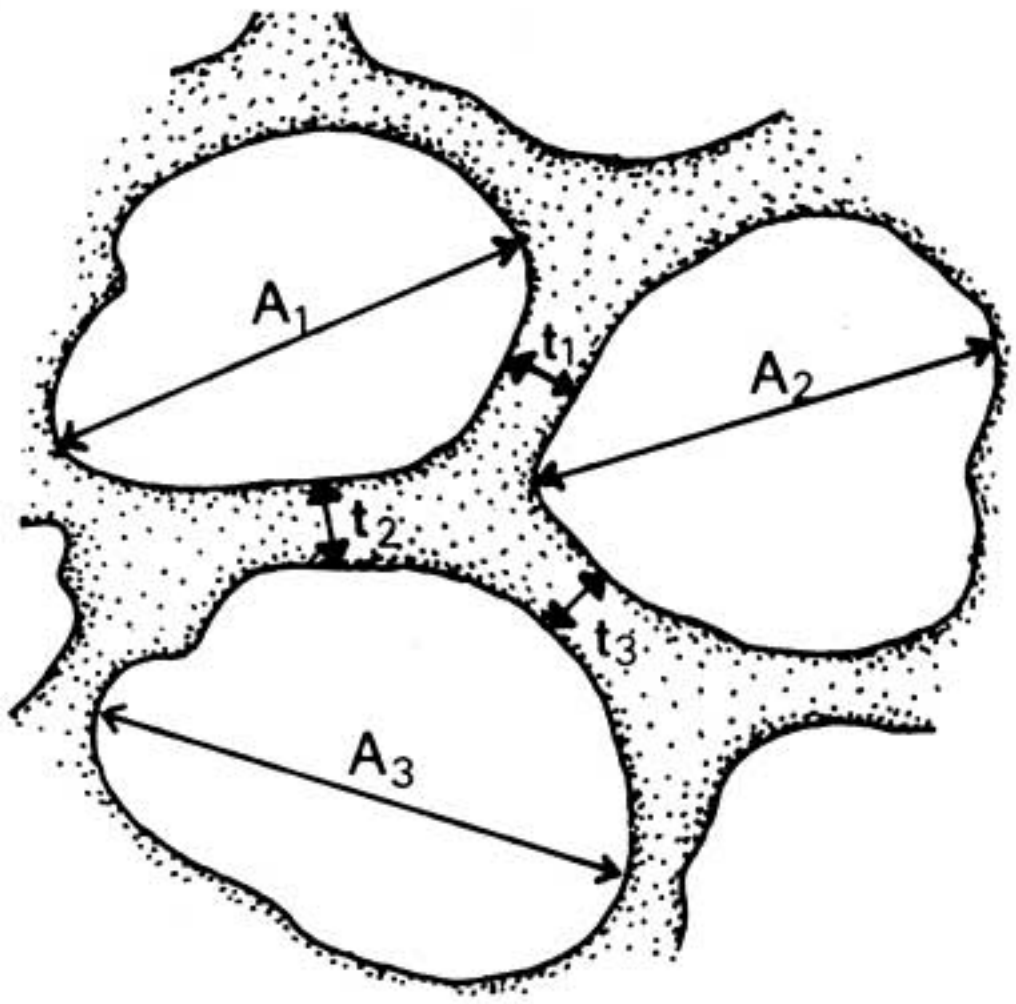
The skeletal microstructures illustrated in the following six plates encompass the broad range of morphologies encountered in echinoderms. These plates illustrate the following skeletal fabrics: Three-dimensional meshworks: rectilinear (Plate 170); galleried (Plate 171); labyrinthic (Plate 172); microperforate (Plate 173A,B); laminar (Plate 173C,D); fascicular (Plate 173E,F). Single layers: retiform (Plate 175A,B); perforate (Plate 175C,D); imperforate (Plate 175E,F). Definitions for these structures are given in the *Glossary* in Volume I.

In addition to these qualitative variations, stereom may also vary considerably between species according to the quantitative features of coarseness, trabecular thickness, and porosity. Stereom coarseness can be quantified using mean pore diameter (A), *i.e.* coarse (A > 25 microns), medium (A = 10-25 microns) and fine (A < 10 microns). Trabecular thickness (t) is measured at the narrowest point between adjacent pores. Mean pore diameter (A) and mean trabecular thickness (t) are both measured from SEM micrographs of surfaces (Text-figure 1). Where pores are oval or irregular in outline, the maximum pore diameter is measured ("A" in Text-figure 1). Surface porosity of stereom is calculated by overlaying a grid on the SEM micrograph of a stereom surface and point-counting pore space against trabeculae.



Text-Figure 1. Measurements of pore diameter (A) and trabecular thickness (t) in echinoderm stereom.

Skeletal composition. All stereom surfaces illustrated are calcitic. Plate 174, Figures A-B also show attaching muscle fibers and collagen bundles, respectively. The molpadiid granules in Plate 174, Figures D-F consist of ferrous phosphate.

Geological age of specimens. All specimens are Recent except where indicated otherwise.

Scale bars. All scale bars are labelled in microns.

Sample preparation methods. All figures in this section are scanning electron micrographs of gold/palladium-coated surfaces. The soft tissue structures in Plate 174, Figures A and B were partially digested in dilute sodium hypochlorite and then critical-point dried.

Guide to the literature. For further surveys of echinoderm stereom the following works should be consulted: **Echinoids:** Jensen (1972), Smith (1980). **Ophiuroids:** Macurda (1976). **Crinoids:** Macurda and Meyer (1975, 1976), Macurda and Roux (1981), Roux (1977a,b). **Holothurians:** Stricker (1985). Additional references are listed in the master bibliography and subject index in Volume I.

Acknowledgement. I am very grateful to David Pawson for supplying me with dermal granules of the holothurian *Molpadia*.

EXPLANATION OF PLATES

PLATE 170. Rectilinear stereom. A. *Eucidaris metularia* (echinoid): outer plate surface of interambulacral plate (epithelial coated surface). B. *Cidaris cidaris* (echinoid): interambulacral plate cross-section. C. *Poriocidaris purpurata* (echinoid): outer surface of interambulacral plate (areole of primary tubercle).

PLATE 171. Galleried stereom. A. *Tripneustes gratilla* (echinoid): outer plate surface of the boss of a primary interambulacral tubercle (collagen insertion area). B. *Ophiura albida* (ophiuroid): outer plate surface of the ligament insertion area on a vertebra. C. *Desmocrinus brevis* (crinoid): cross-section through a columnal (ligament insertion area). D. *Psammechinus miliaris* (echinoid): cross-section through an interambulacral plate - middle plate layer (collagen sutural fibers).

PLATE 172. Labyrinthic stereom. A. *Brisingella coronata* (asteroid): outer surface of adambulacral plate showing the sharp boundary between coarse labyrinthic stereom that makes up the shaft of the ossicle and the very much finer labyrinthic stereom forming the ambulacral muscle attachment area. B. *Ophiocoma erinaceus* (ophiuroid): outer surface of muscle attachment flange on proximal vertebra. C. *Calveriosoma hystrix* (echinoid): outer interambulacral plate layer (epithelial-coated surface). D. *Tripneustes gratilla* (echinoid): cross-section of interambulacral plate - inner plate layer. E. *Neocrinus blakei* (crinoid): outer surface of ambulacral lappet plate (epithelial-coated surface). F. *Echinus esculentus* (echinoid): outer surface of aboral face of auricle (internal mesodermal lining).

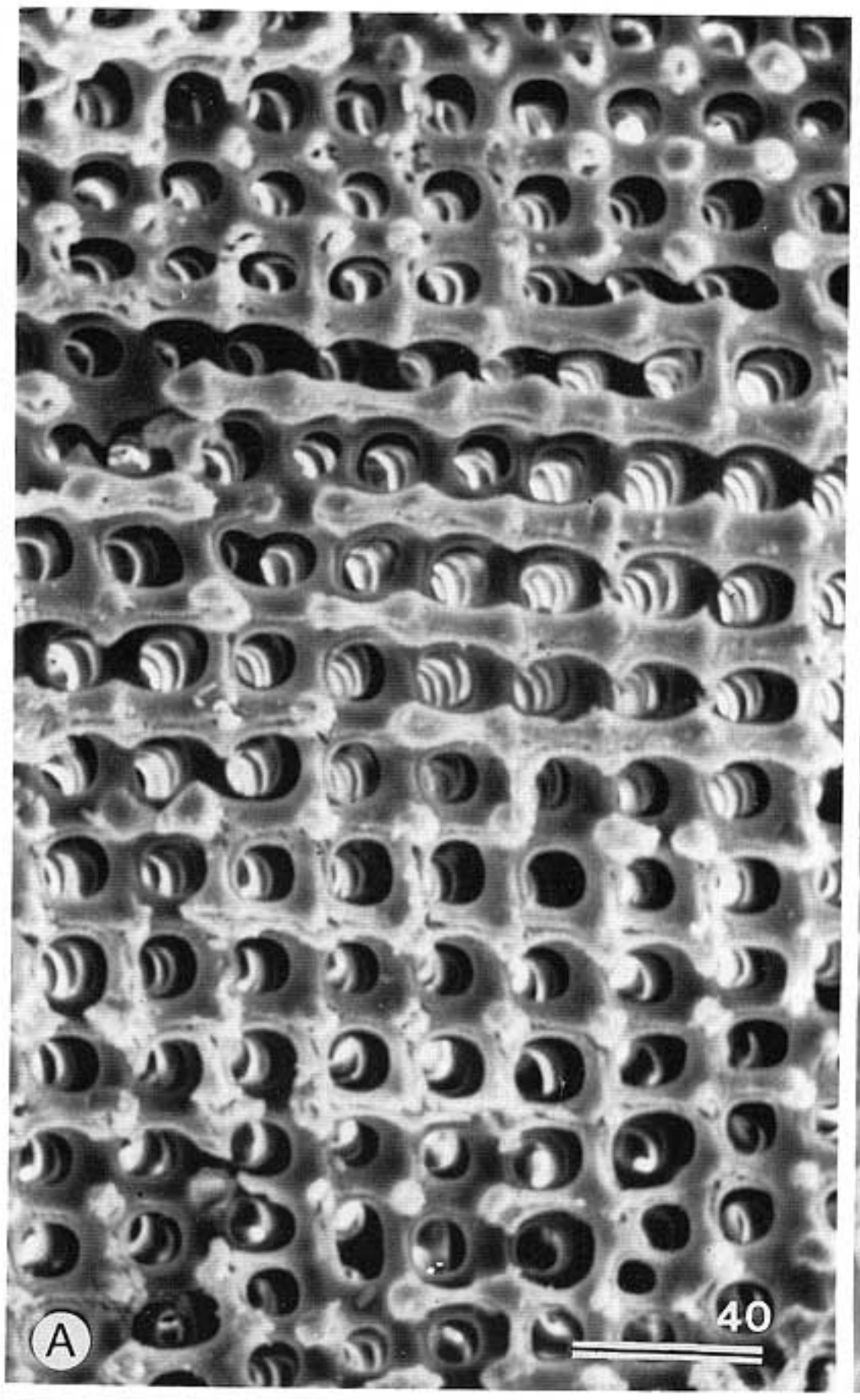
PLATE 173. Fascicular, microperforate, laminar and labyrinthic stereom. A-B. Microperforate stereom in *Echinolampas crassa* (echinoid): interambulacral plate cross-section - inner plate layer. C. Laminar (Lm) and labyrinthic (Lb) stereom in *Eupatagus hastingsi* (echinoid, Middle Eocene, Barton, Hampshire, U.K.): interambulacral plate cross-section with inner plate surface at the top. Arrows indicate boundary between outer plate surface and face of cross-section. D. Laminar (Lm) and labyrinthic (Lb) stereom in *Paramaretia peloria* (echinoid): cross-section of interambulacral plate - middle plate layer. E. Fascicular (F) and labyrinthic (Lb) stereom in *Astropecten irregularis* (asteroid): outer surface of ambulacral ossicle at approximately mid-length. F. Fascicular stereom of *Echinocardium cordatum* (echinoid): cross-section of inner layer of an interambulacral plate.

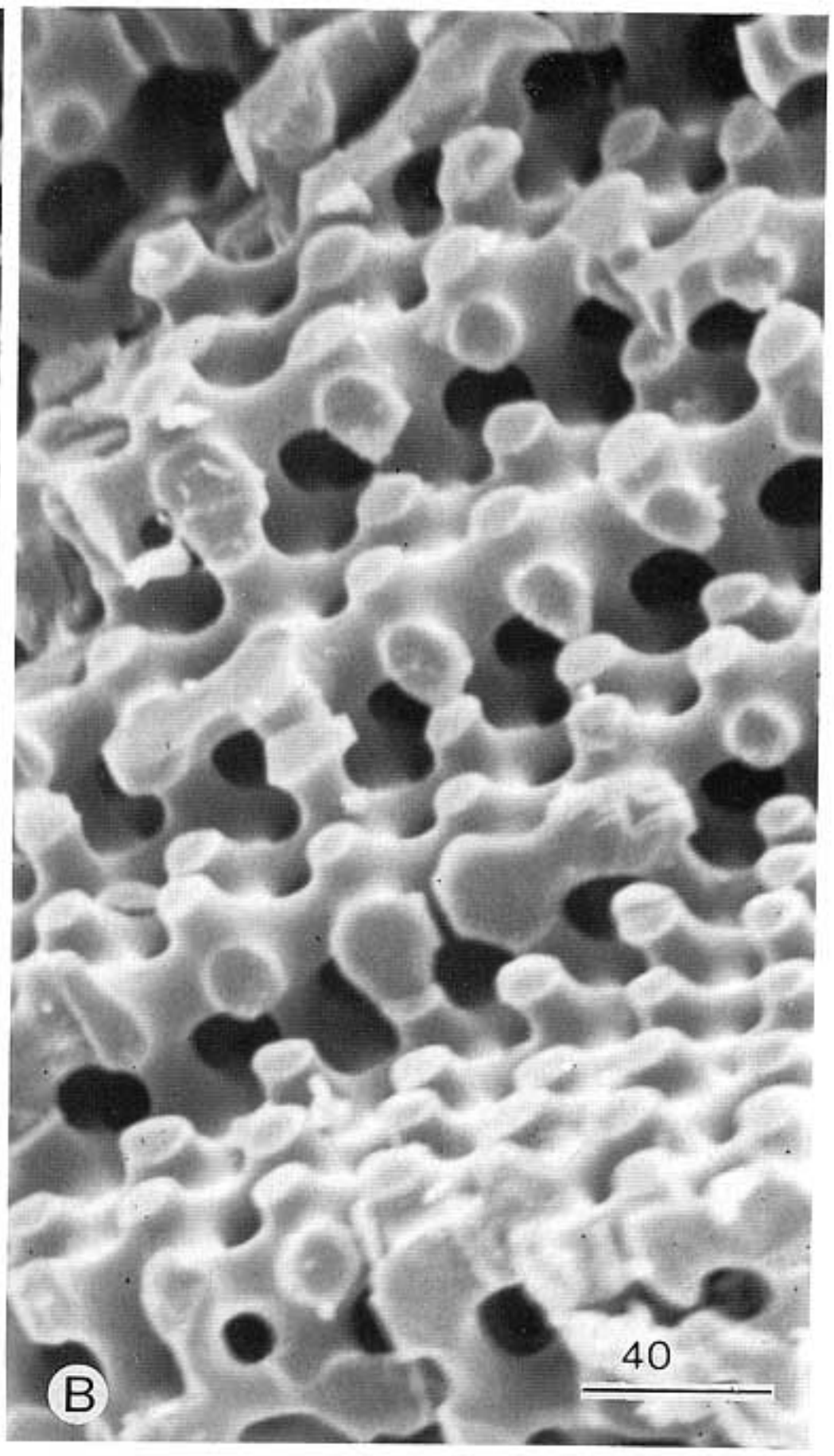
PLATE 174. A. Intervertebral muscle fibers attaching to a fine retiform stereom layer on the vertebra of *Ophiothrix fragilis* (ophiuroid). Note how the muscle fibers splay out as they reach the stereom and are wrapped around the fine surface trabeculae. Preparation

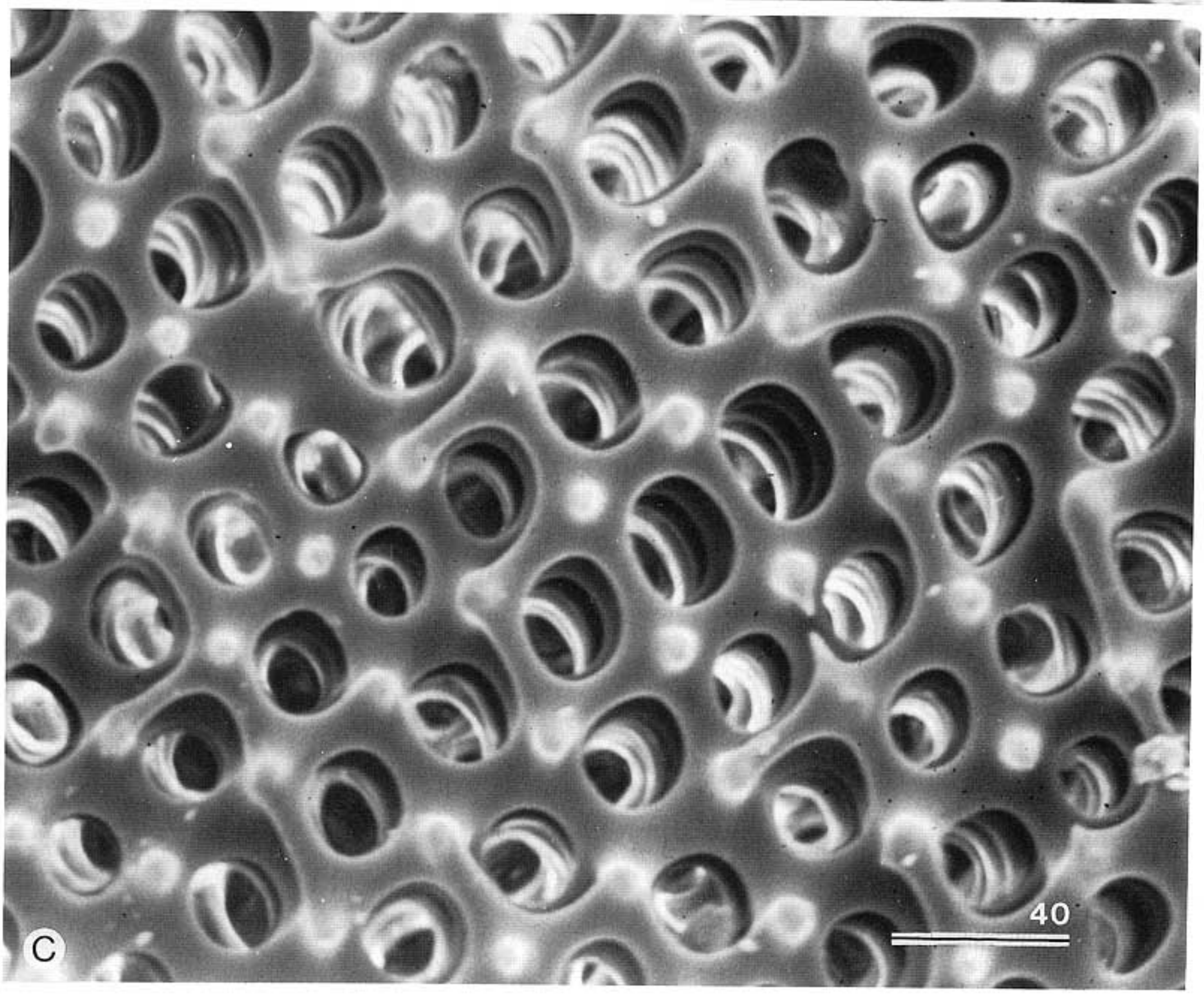
method 20. B. Spine catch apparatus (collagen) inserting into galleried stereom forming the boss of a primary interambulacral tubercle of *Psammechinus miliaris* (echinoid). Note how the collagen bundles penetrate into the galleries of the stereom. Preparation method 20. C. Ambulacral spine of *Brisingella coronata* (asteroid) in cross-section; fractured trabeculae showing concentric growth pattern. D-F. Ferrous phosphate dermal granule of *Molpadia oolitica* (holothurian). D. Single dermal granule; note the characteristic irregular accretionary structure. E. Higher magnification of D, showing the subspherical subunits which comprise the dermal granule. F. Higher magnification of E, showing that the subspherical subunits themselves consist of much smaller subunits.

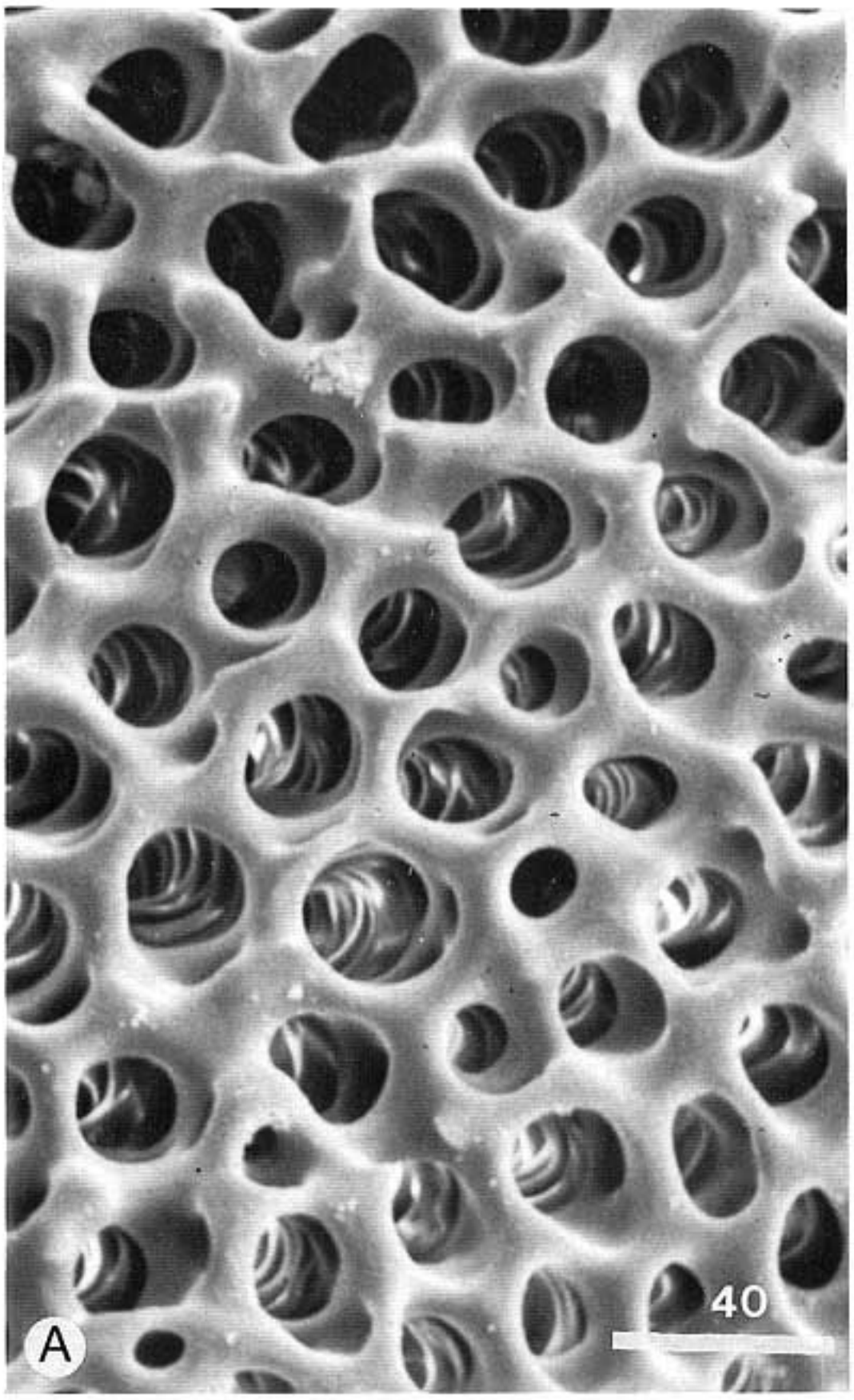
PLATE 175. Retiform, perforate, imperforate and labyrinthic stereom. A-B. Retiform stereom layer (RL) forming the muscle attachment platform in a tubercle of *Brissopsis lyrifera* (echinoid). A. Cross-section of plate; note the dense, perforate stereom layer (PL) lying just below the retiform layer, underlain by labyrinthic stereom (Lb). The arrow indicates the boundary between the outer plate surface and the face of the cross-section. B. Outer plate surface with underlying coarse labyrinthic stereom on the top left and bottom right. C-D. Perforate stereom layers. C. Cross-section of a ventral arm plate of *Ophiocoma erinaceus* (ophiuroid), showing a perforate sterom layer (PL) and an underlying labyrinthic stereom layer (Lb); exterior surface is toward the left; arrows mark the boundary between the outer plate surface and the face of the cross-section. D. Internal surface of an interambulacral plate of *Stomopneustes variolaris* (echinoid). E-F. Imperforate stereom (I). E. Cross-section through an interambulacral plate of *Echinoneus cyclostomus* (echinoid) showing one glassy tubercle (external surface at top). L = labyrinthic stereom. F. Plastron tubercle of *Brissopsis lyrifera* (echinoid) showing imperforate (I) mamelon and platform (articulation surfaces) surrounded by two rings of fine, labyrinthic stereom (Lb), the inner for collagen attachment, the outer for muscle attachment.

PLATE 170





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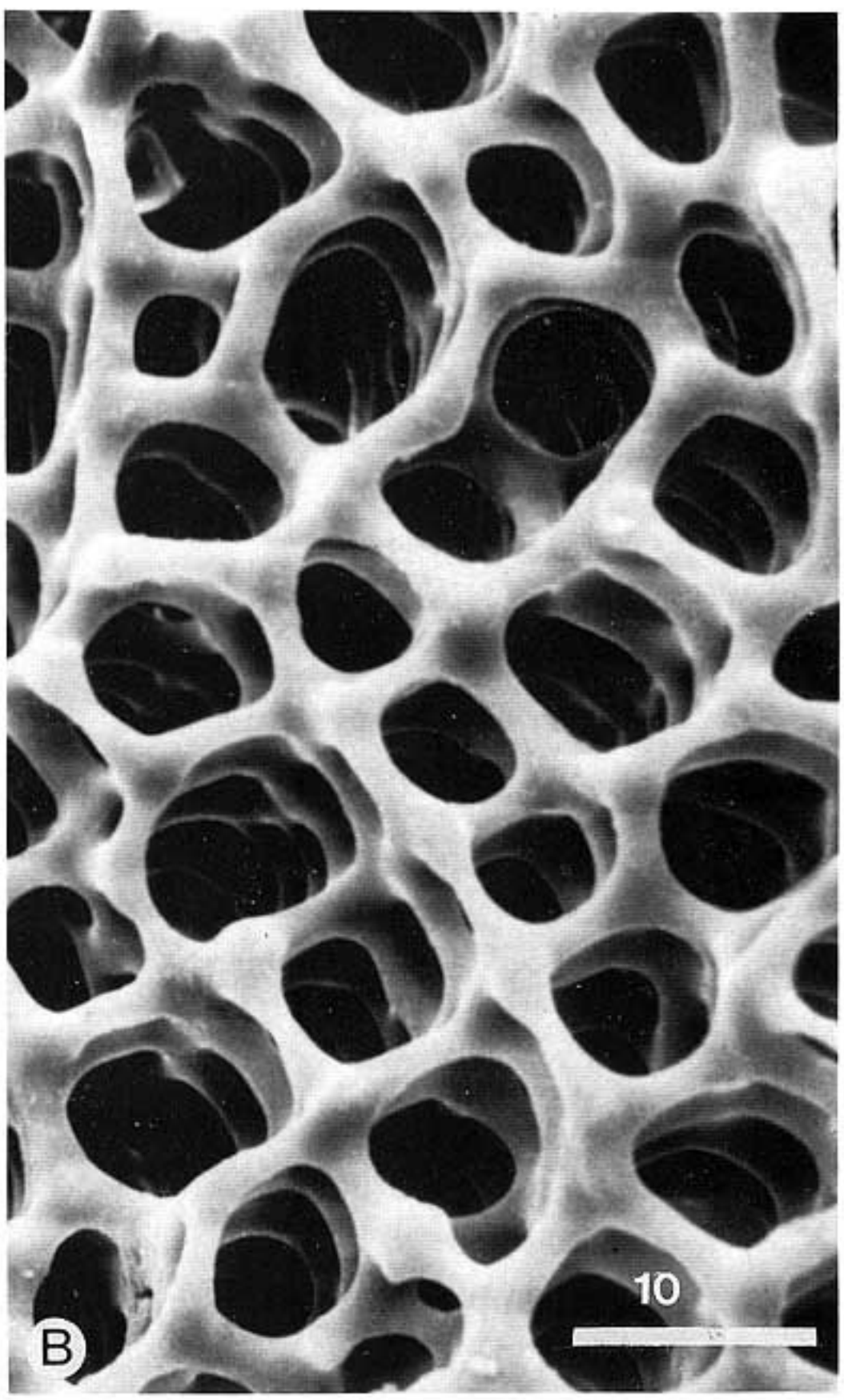
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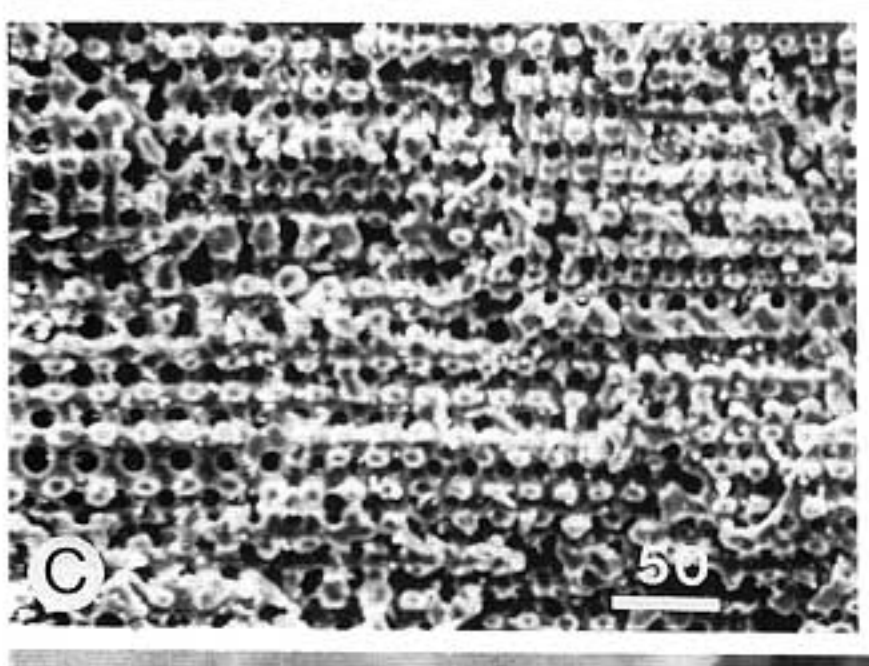
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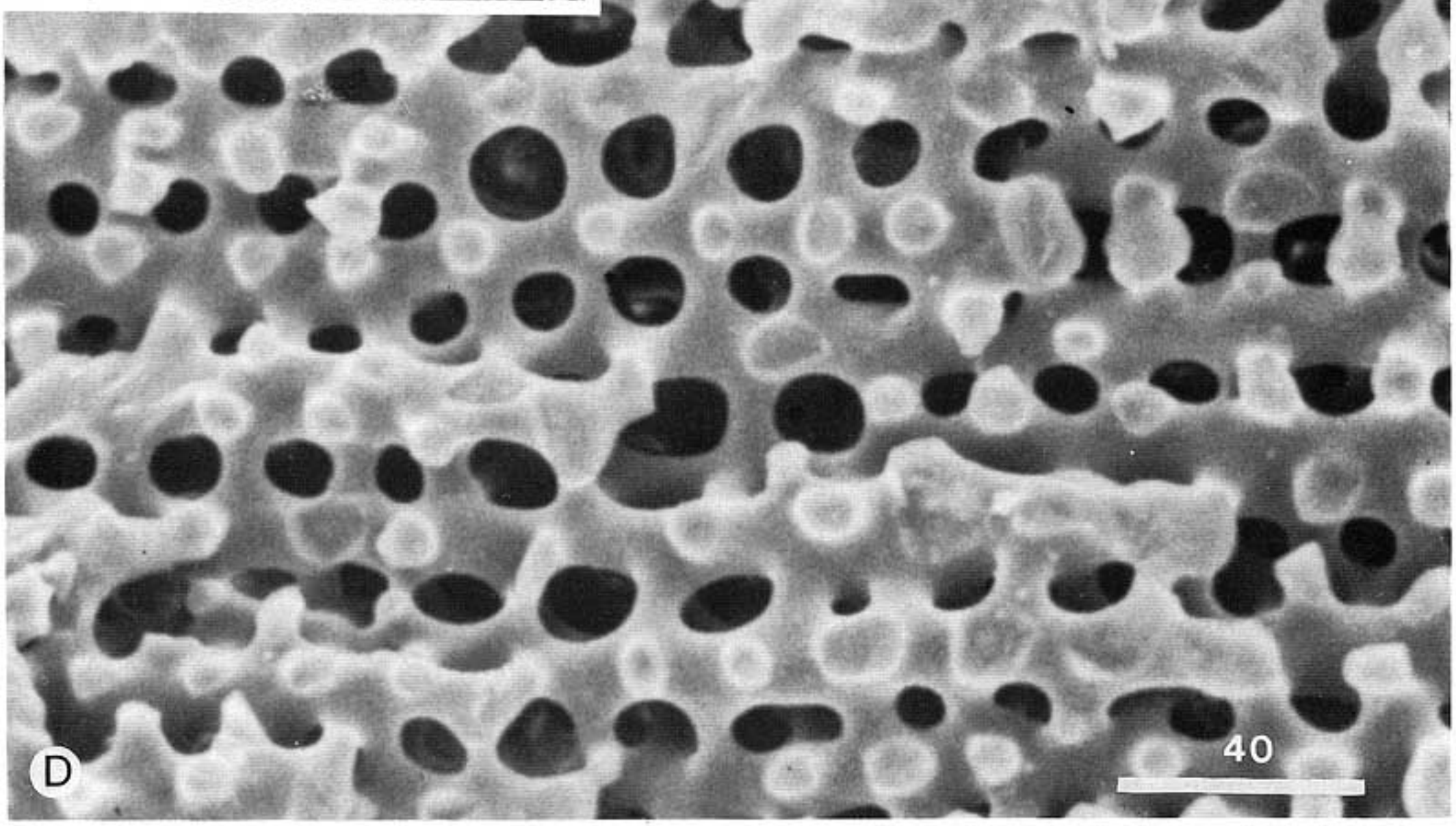
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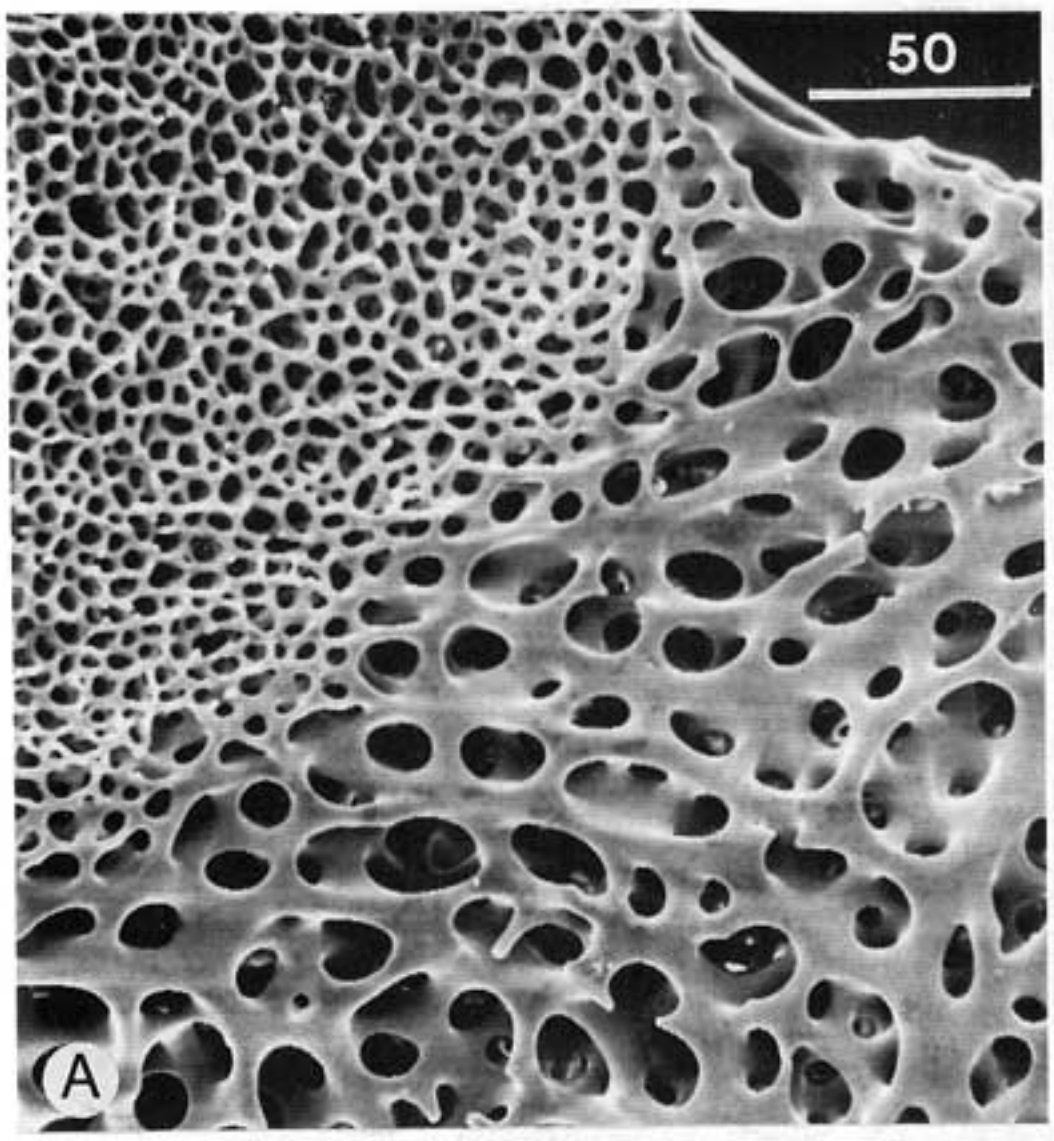
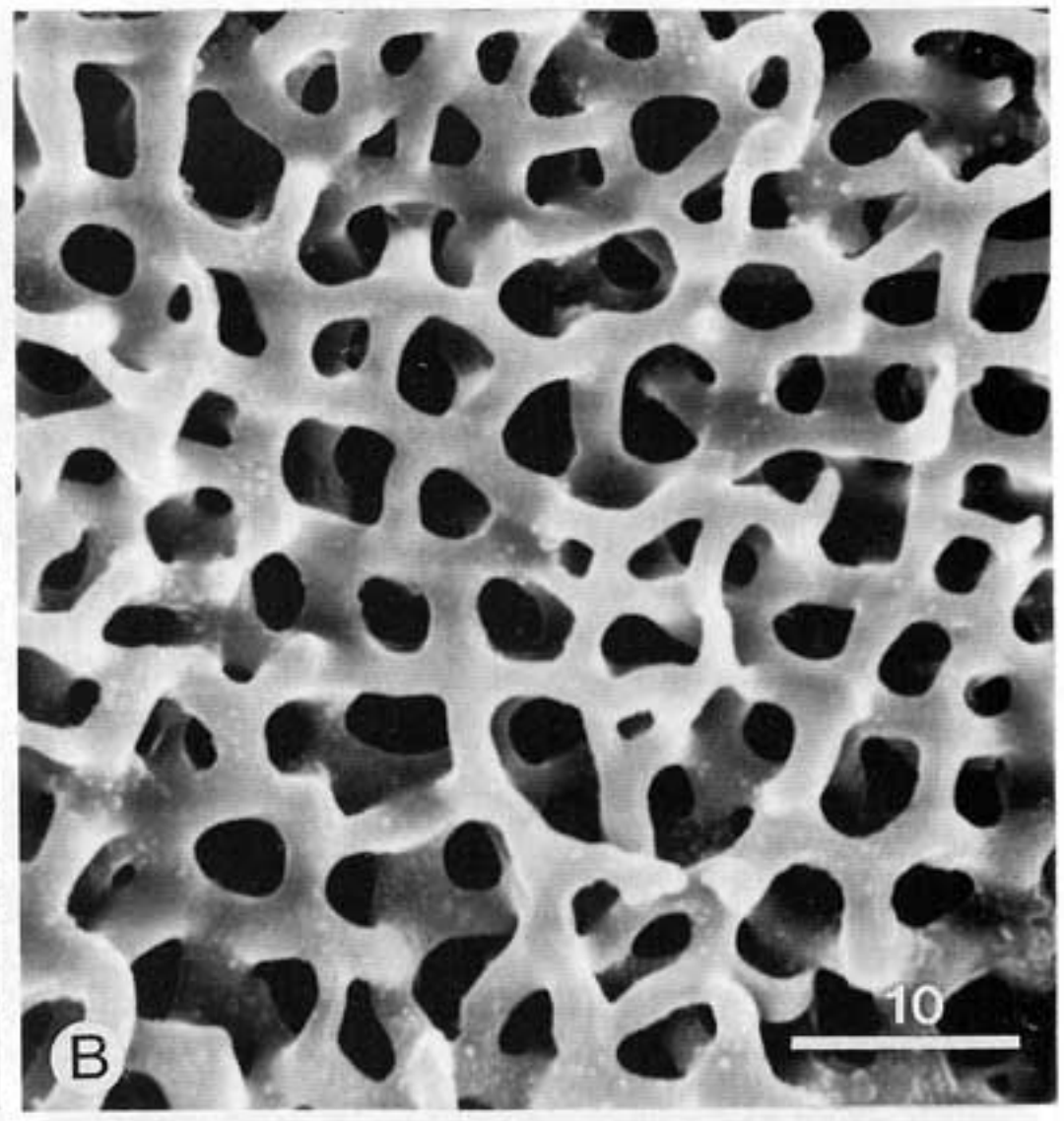
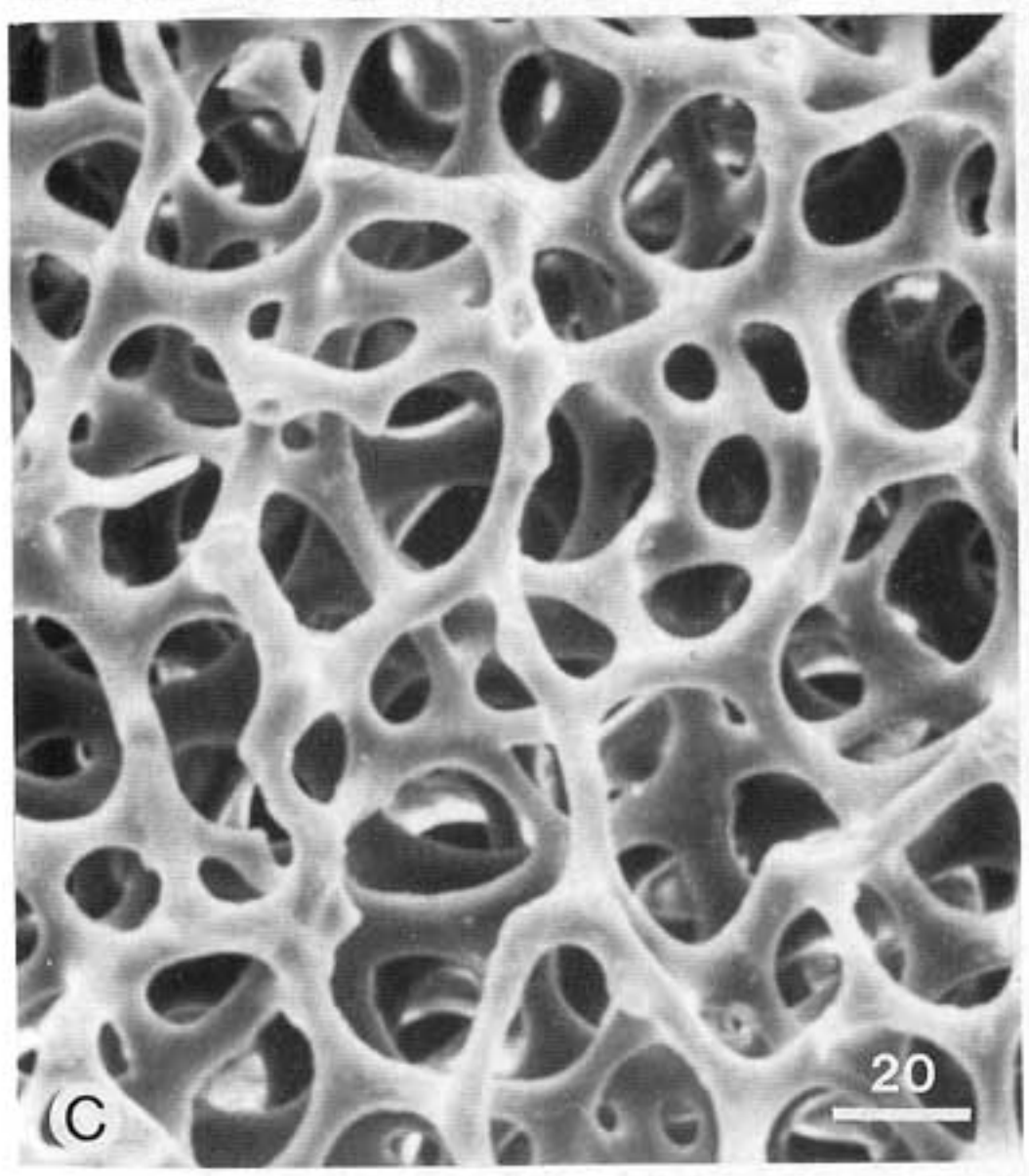
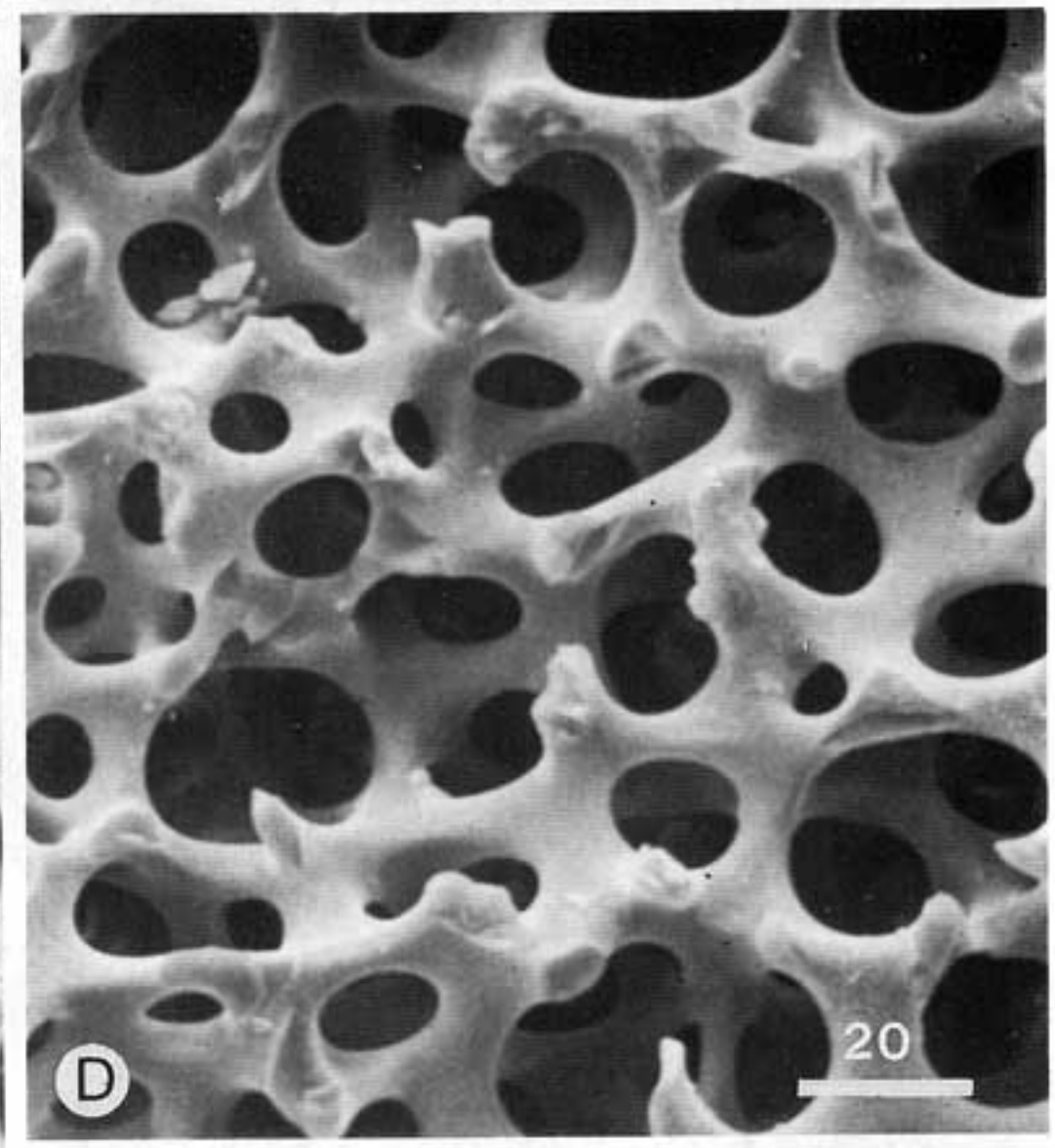
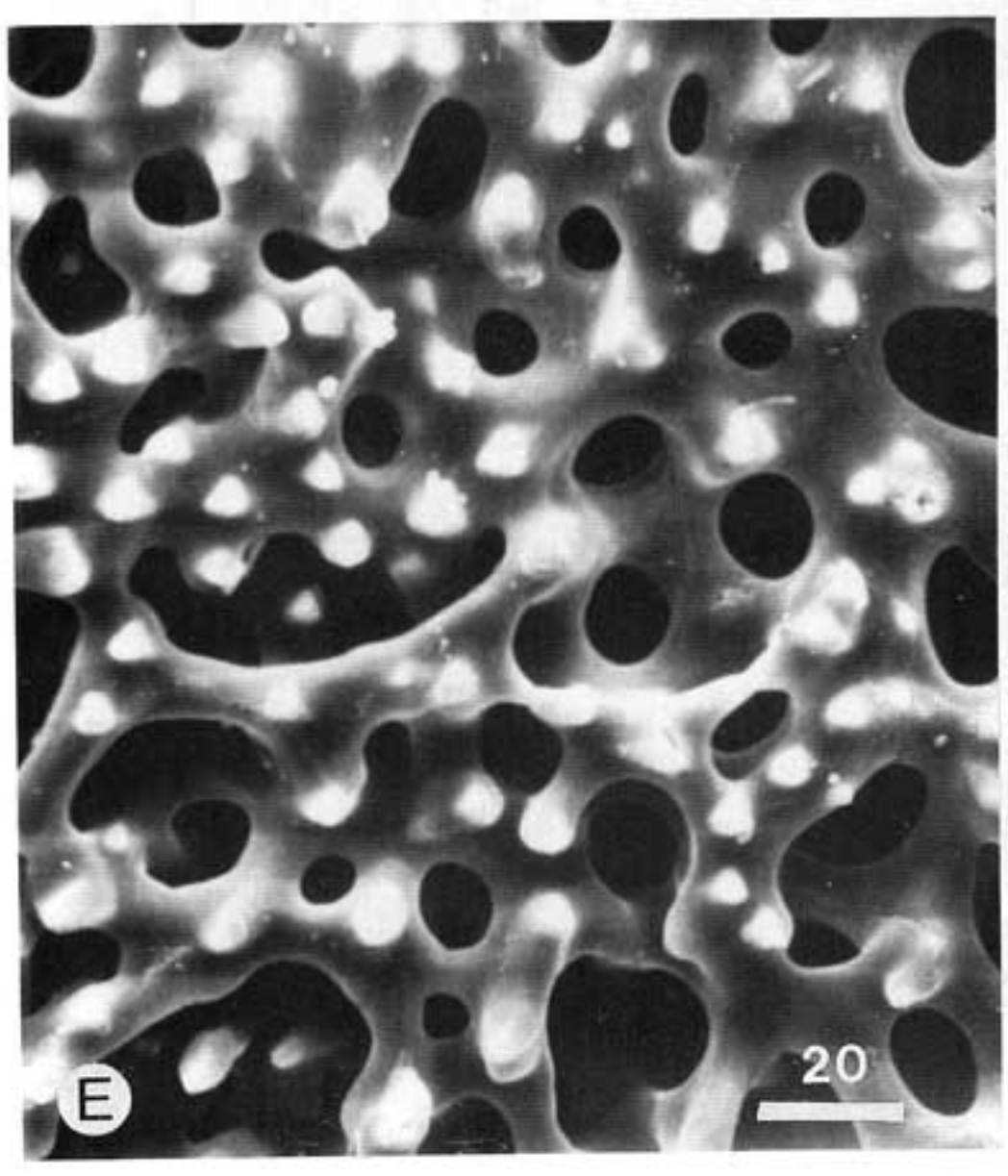
PLATE 172

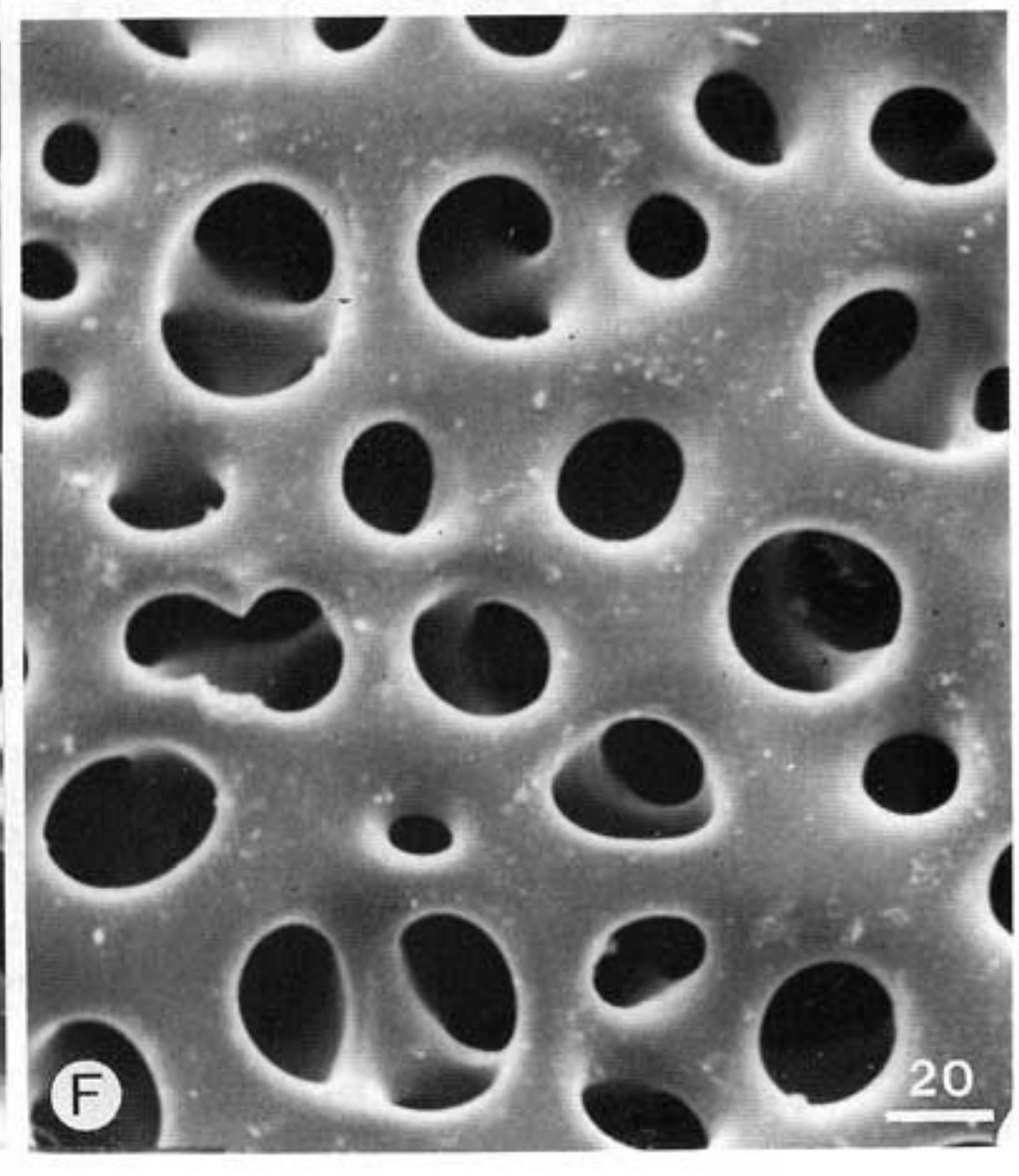










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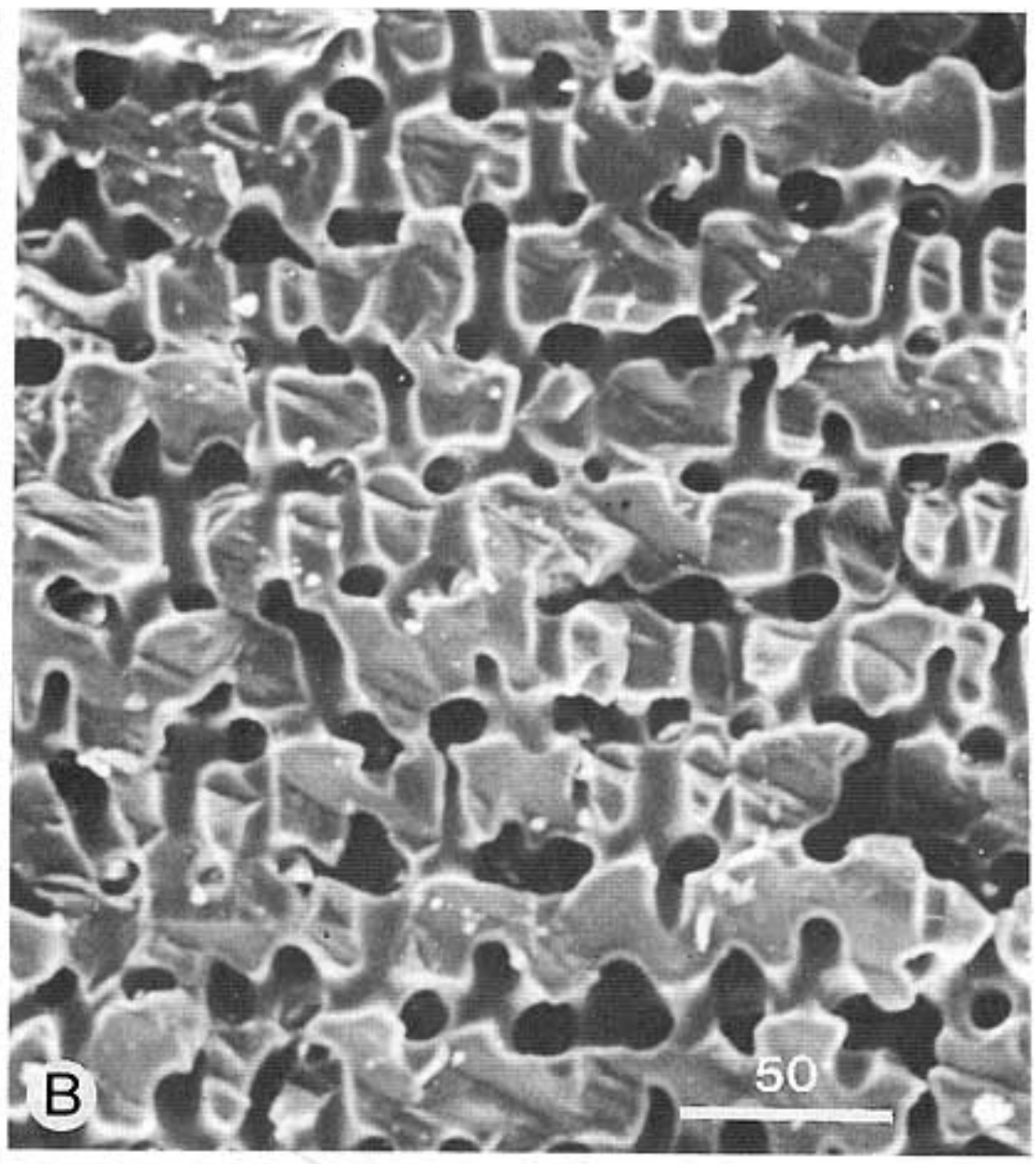
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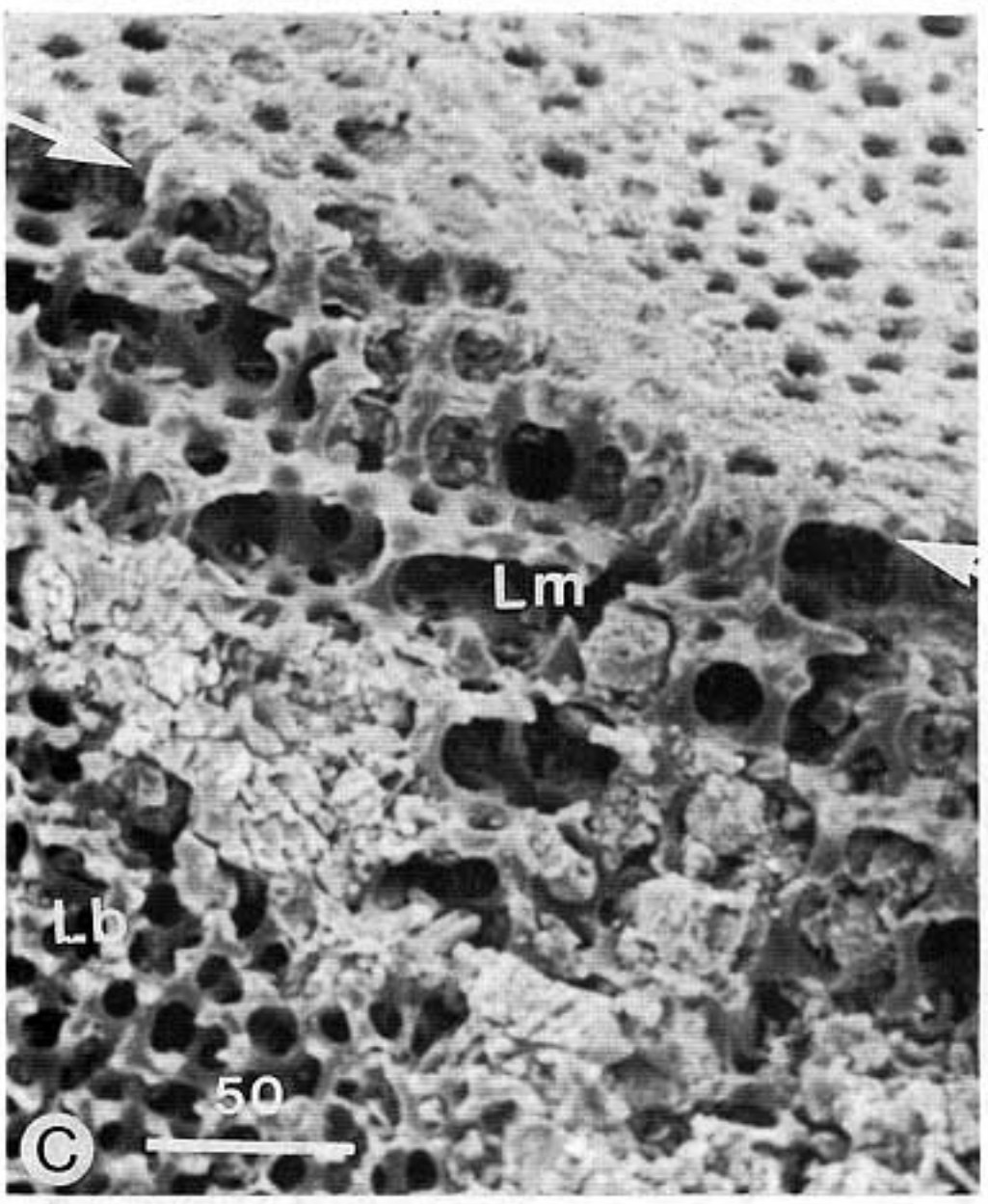
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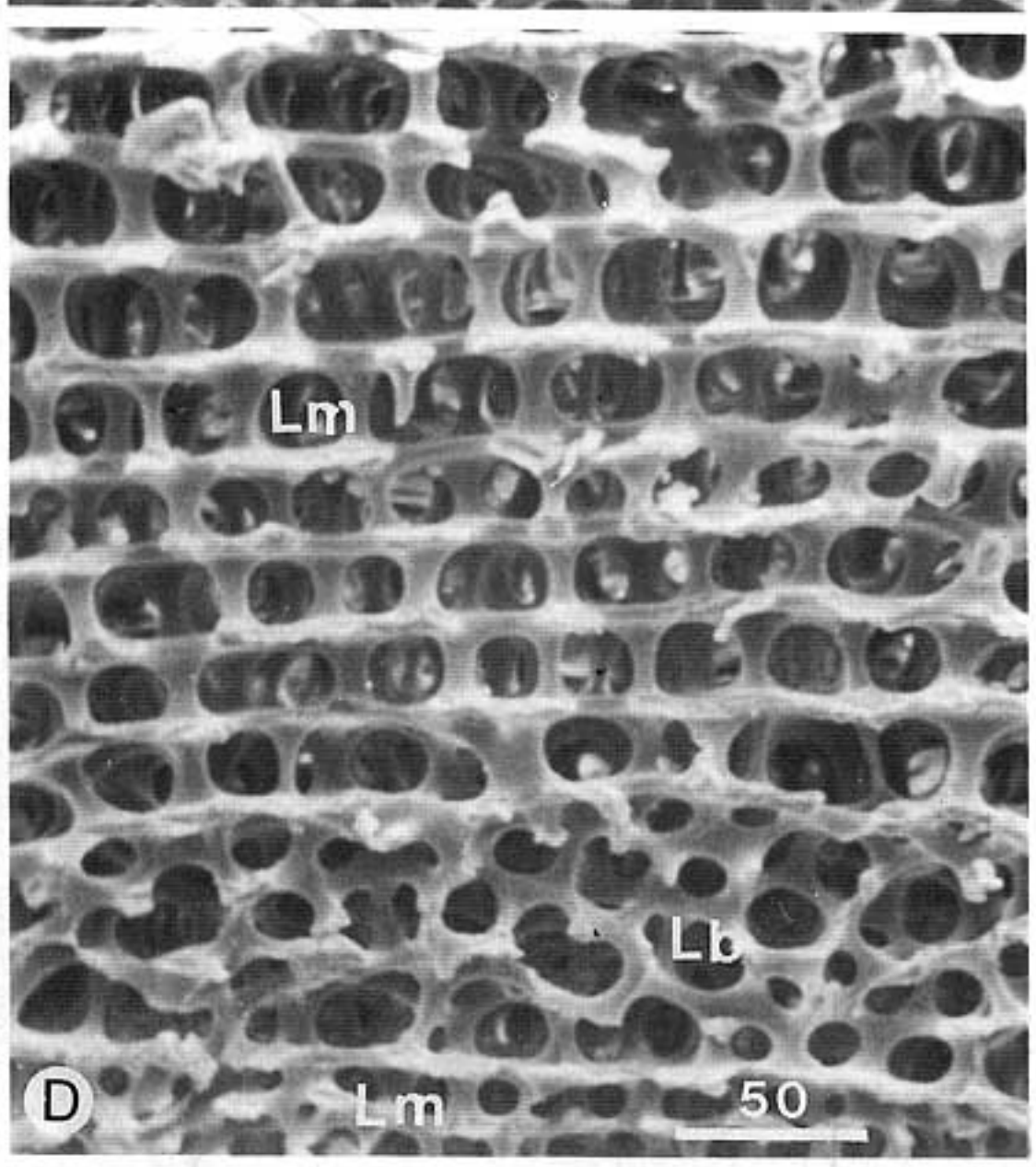
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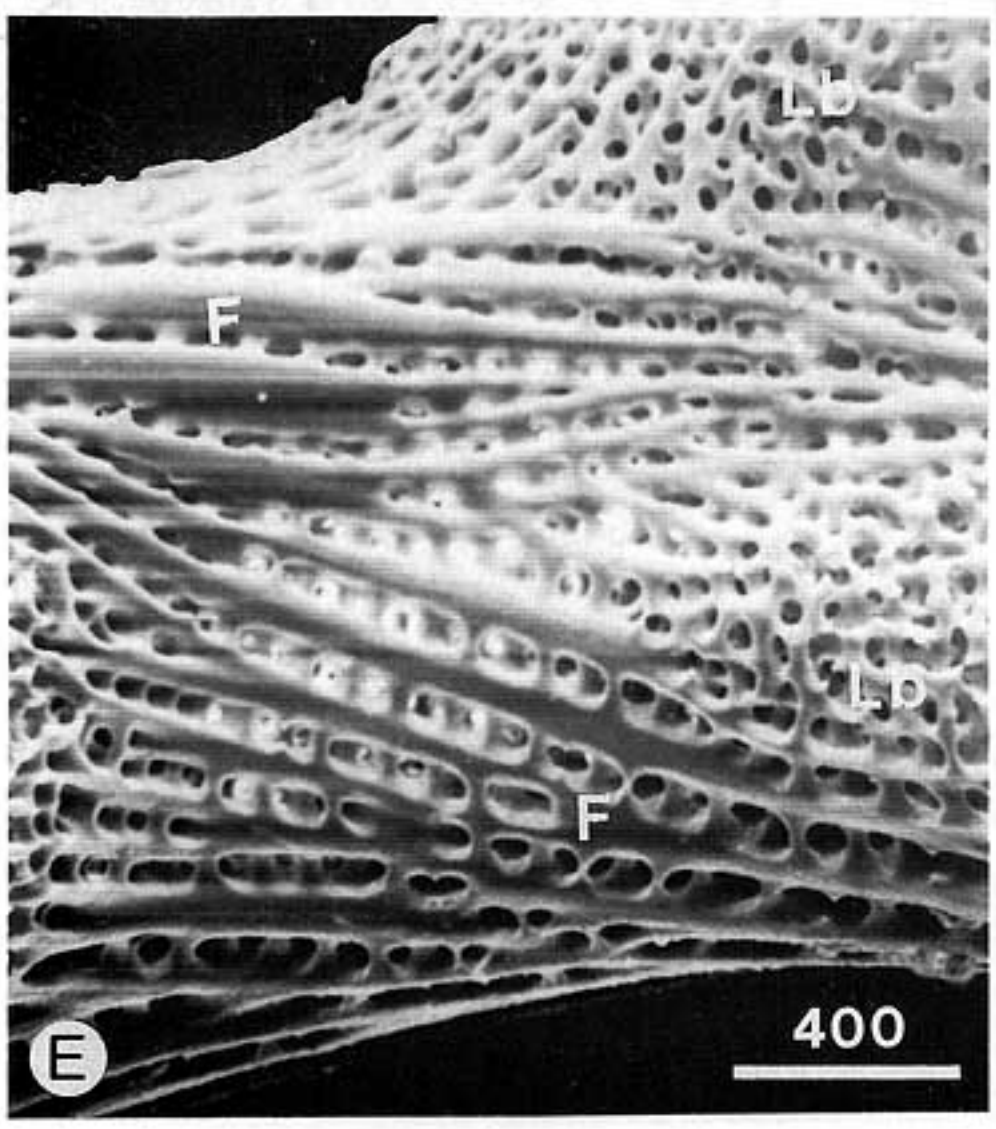
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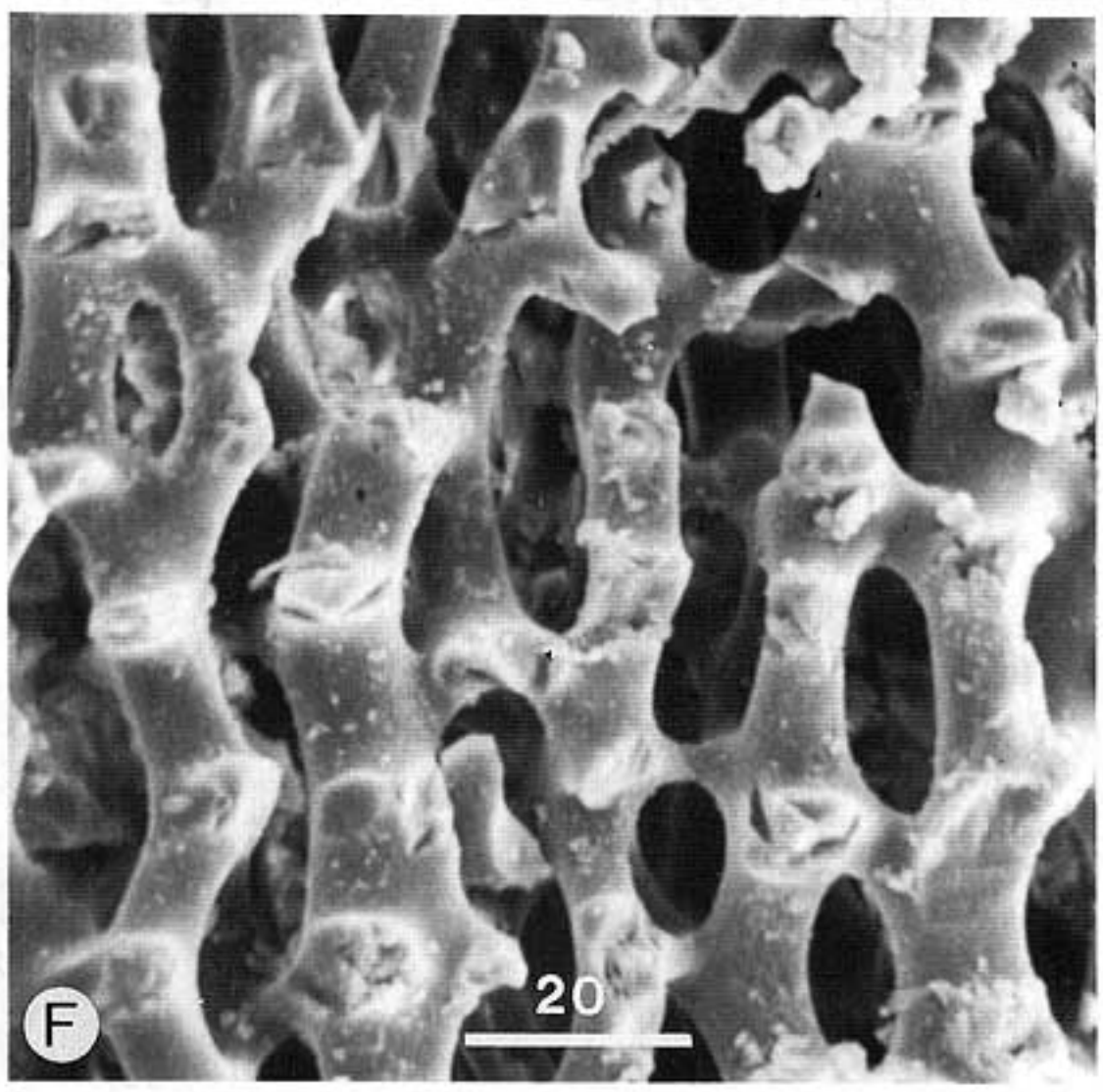
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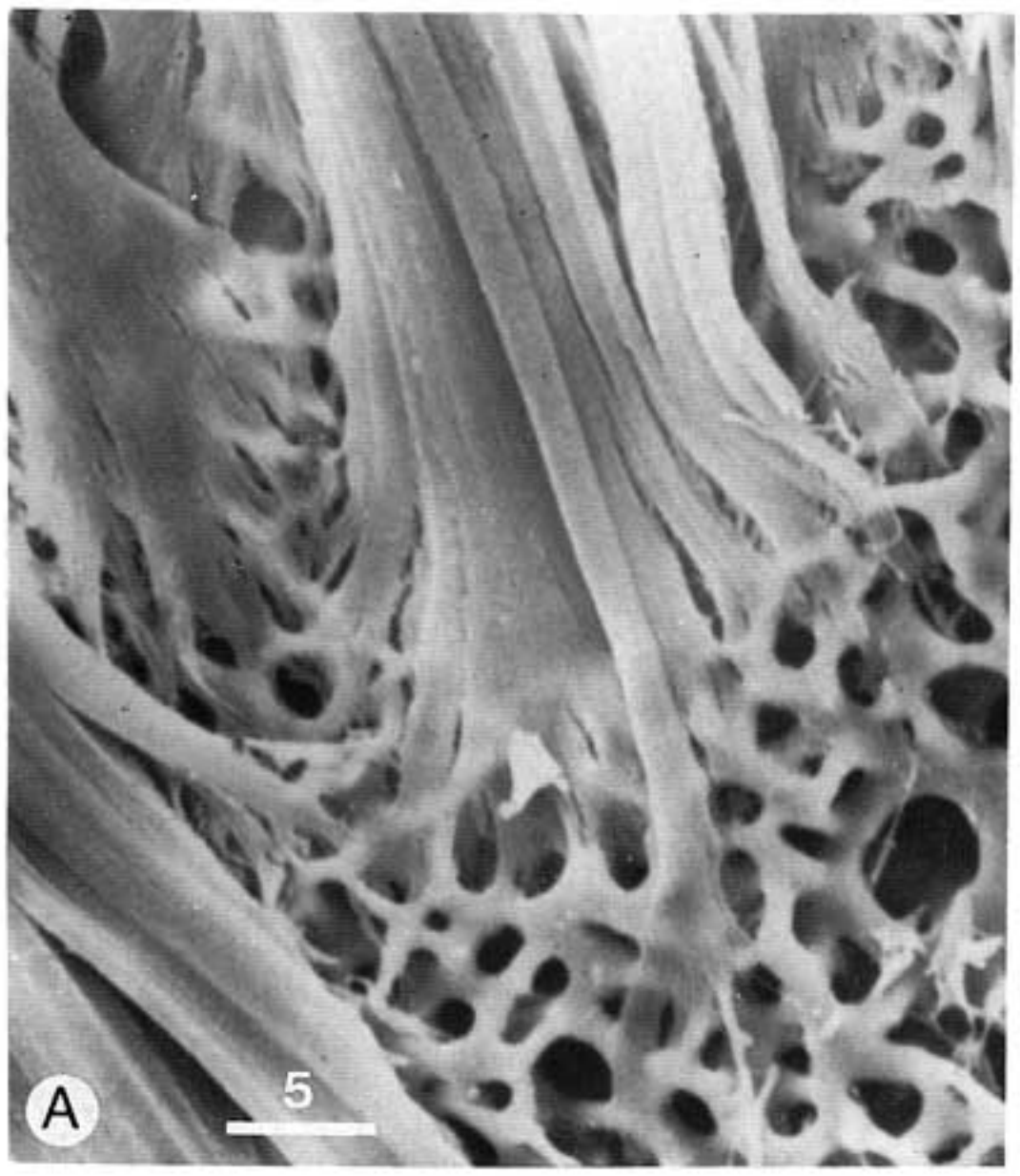
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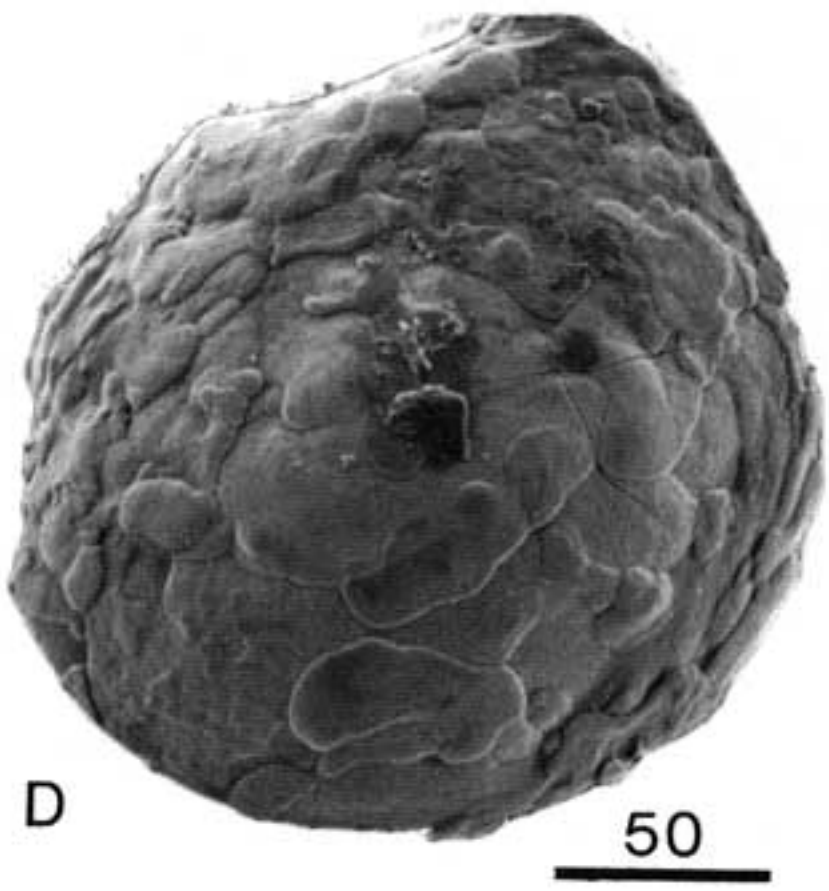
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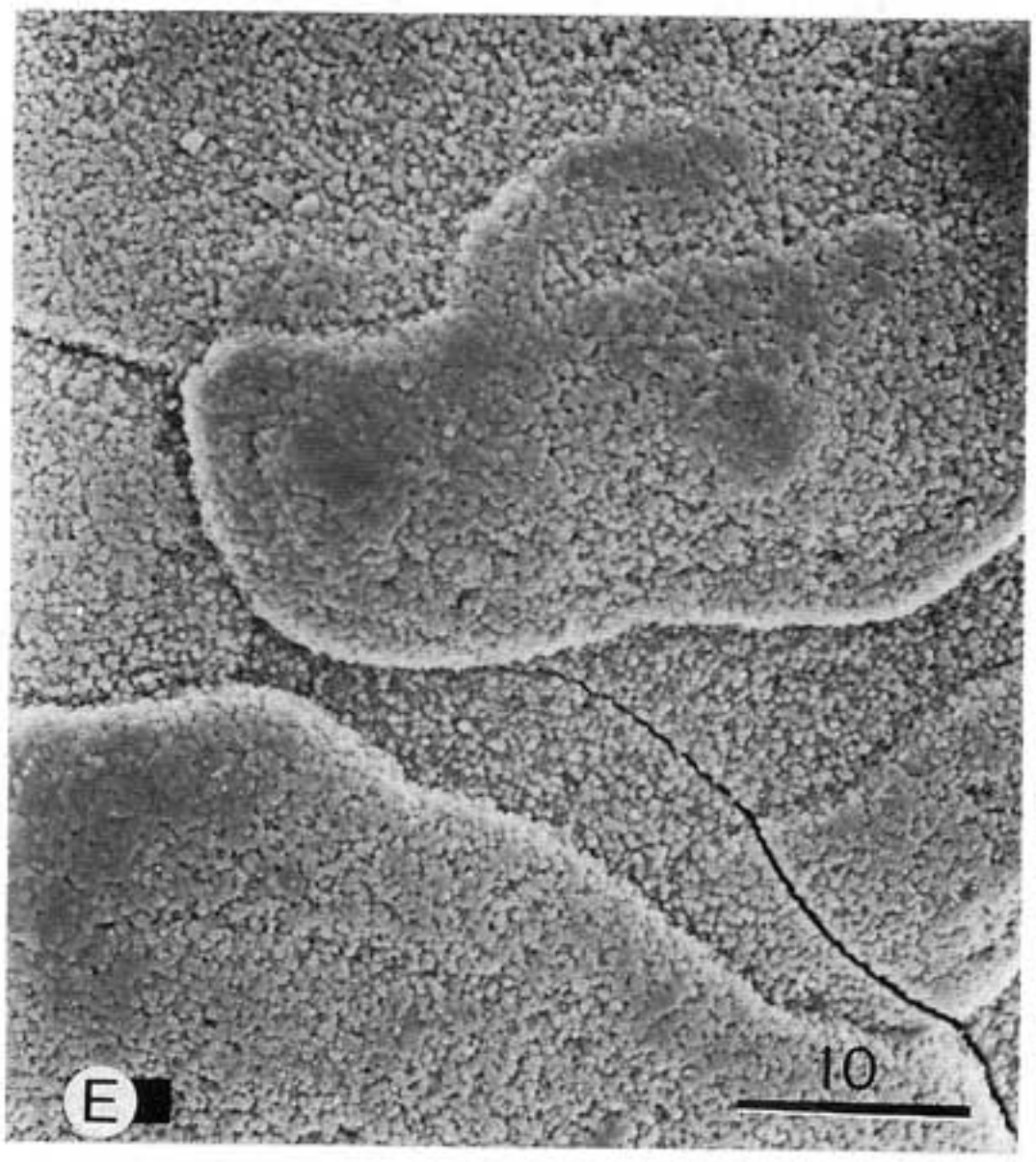
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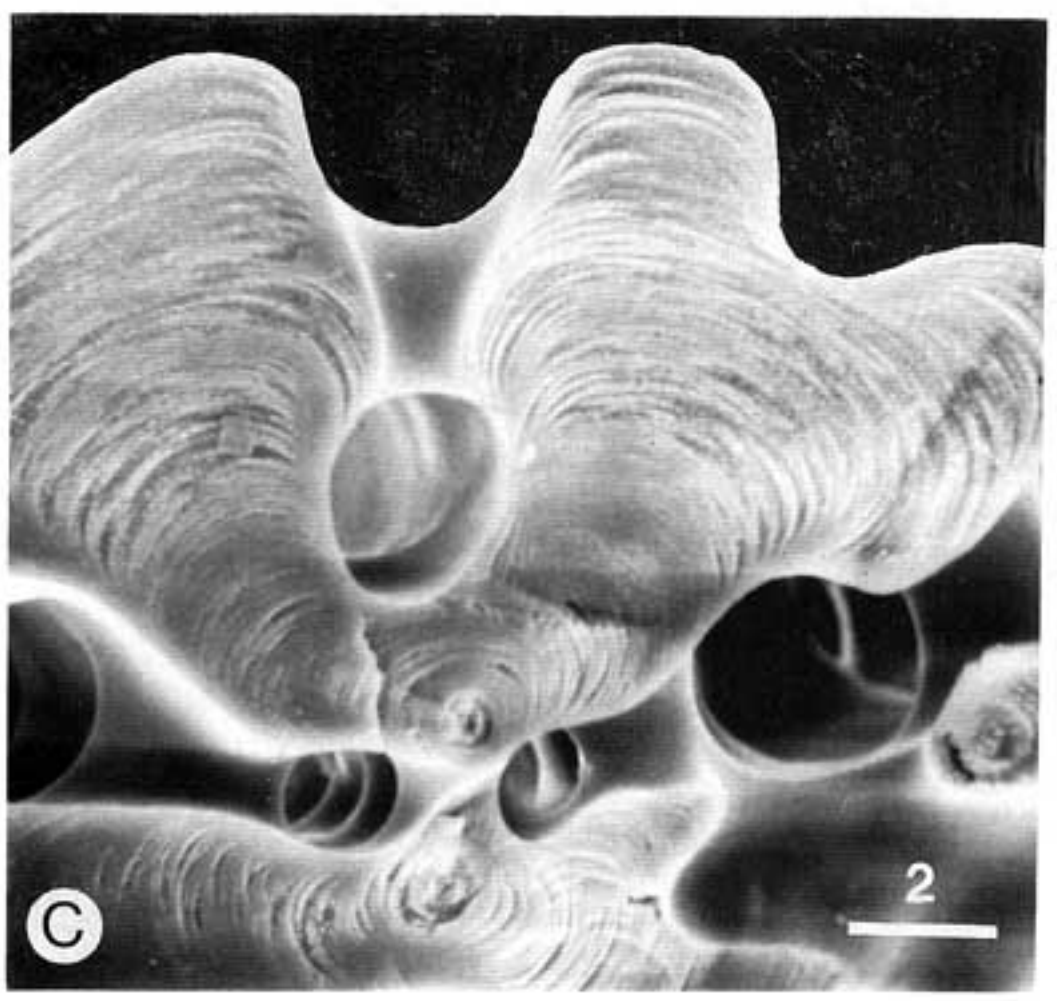
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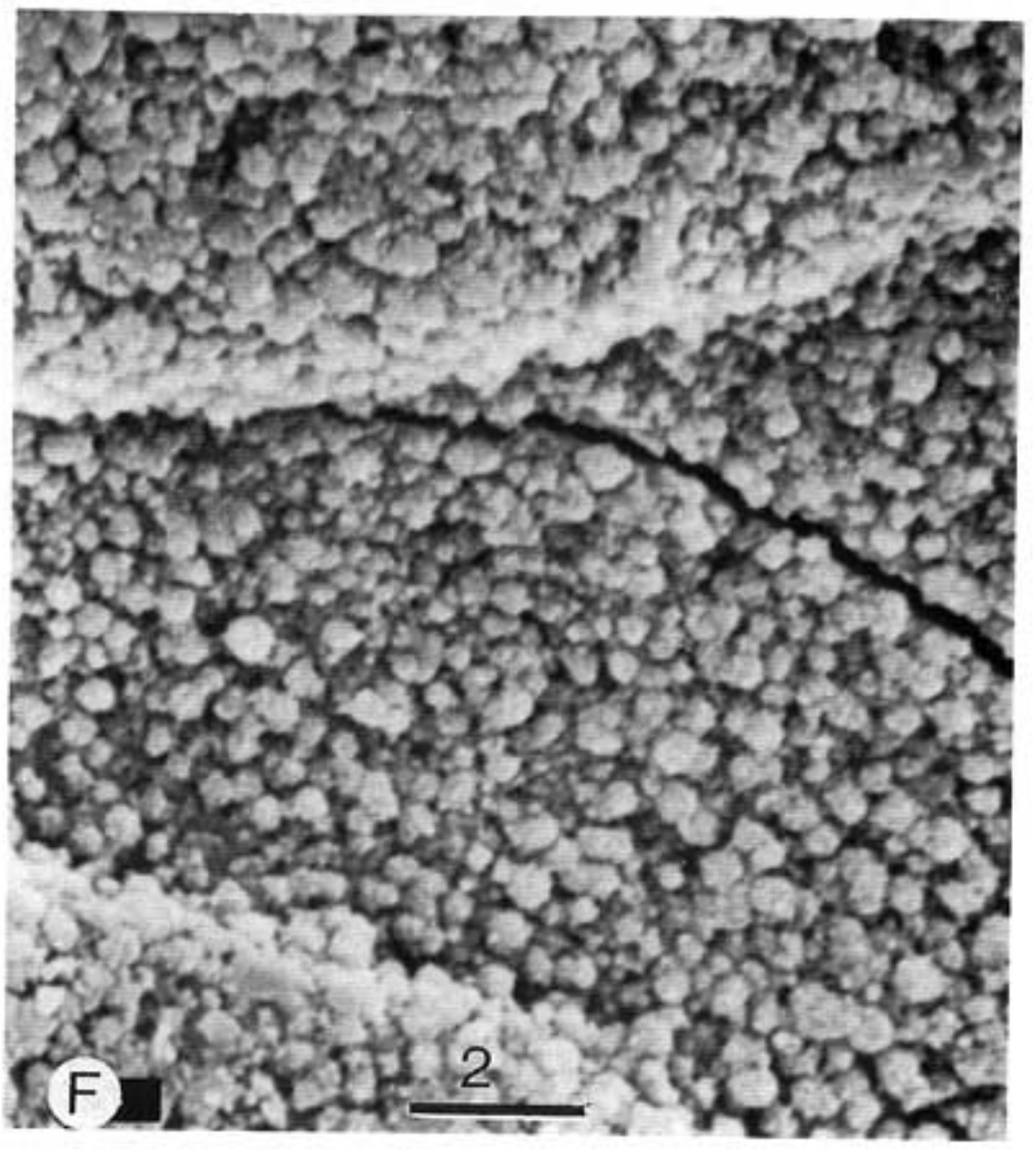
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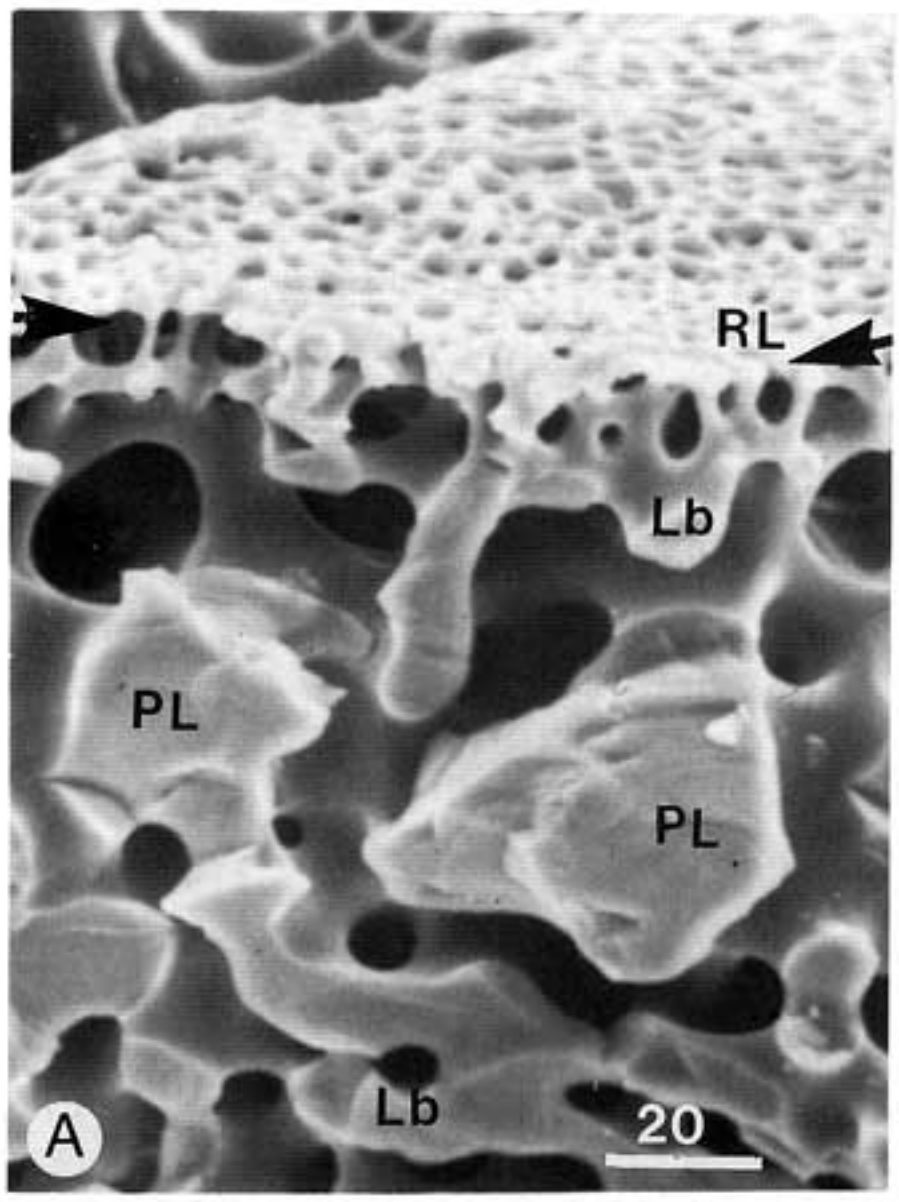
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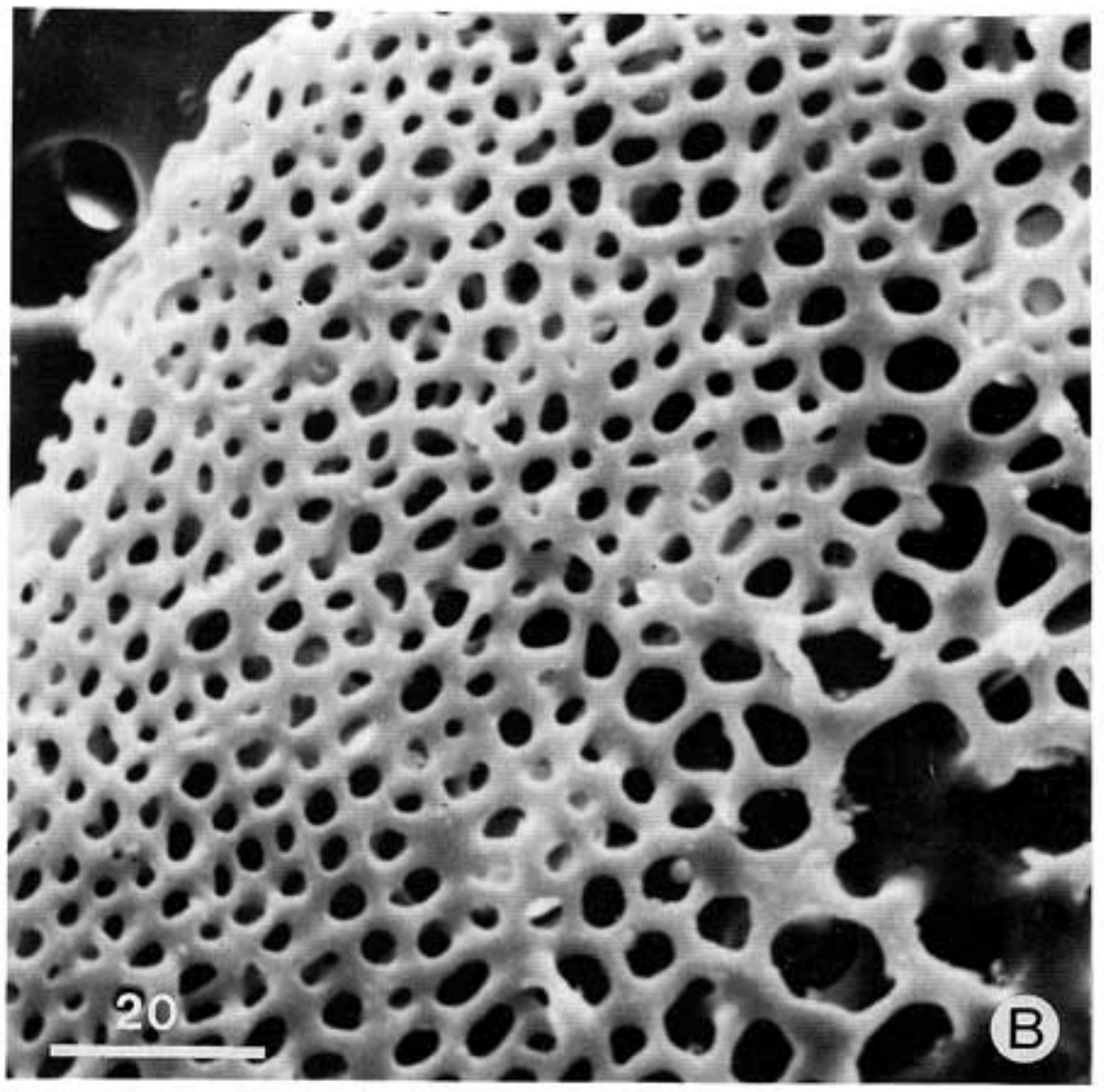
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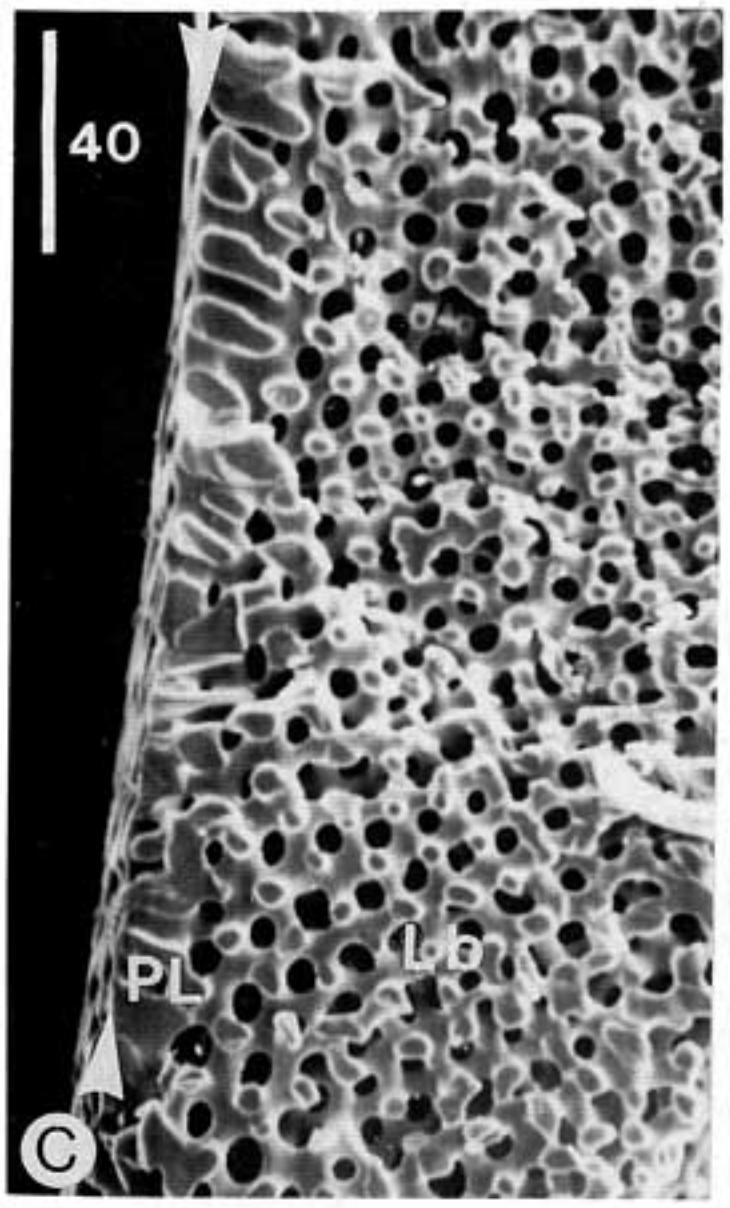
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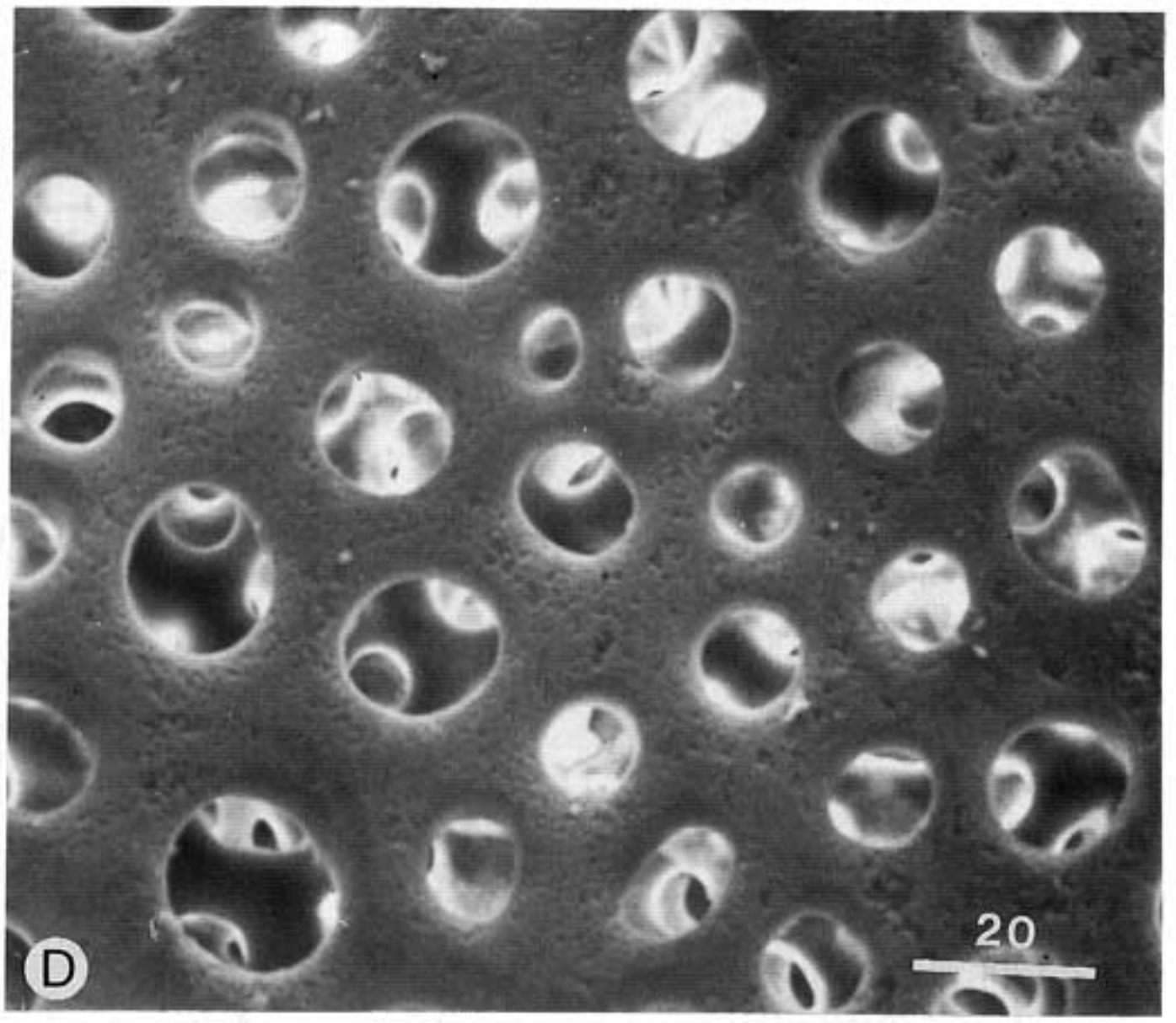
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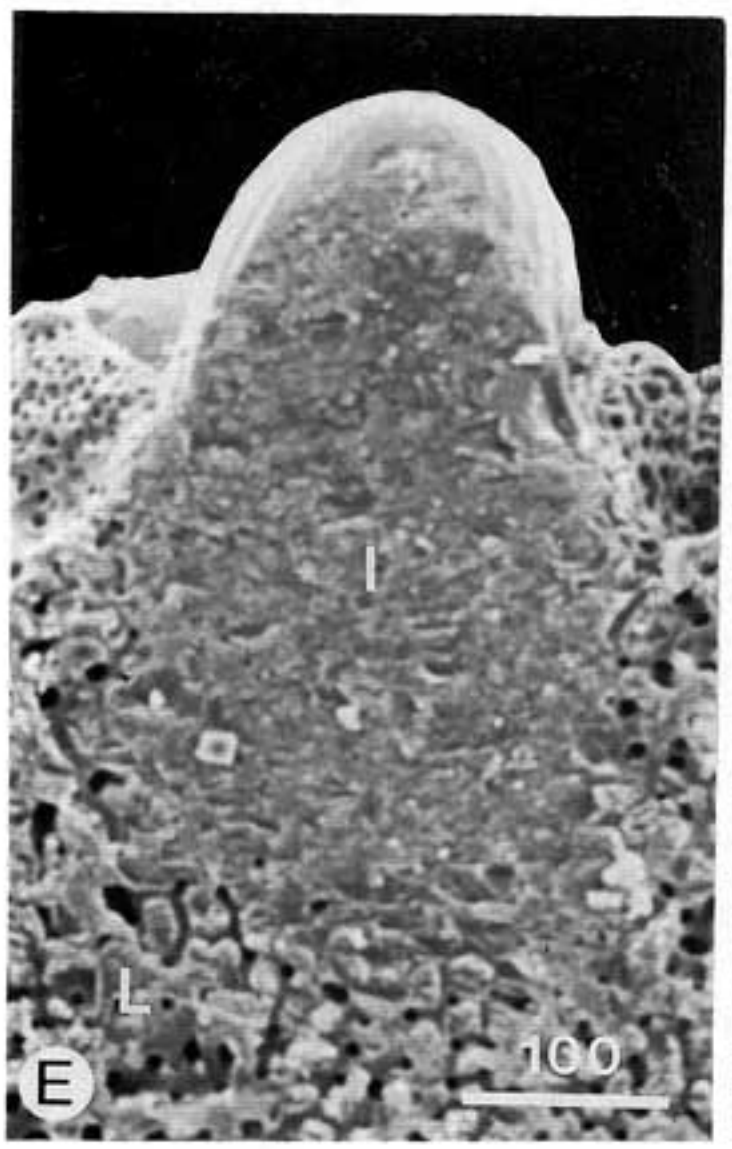
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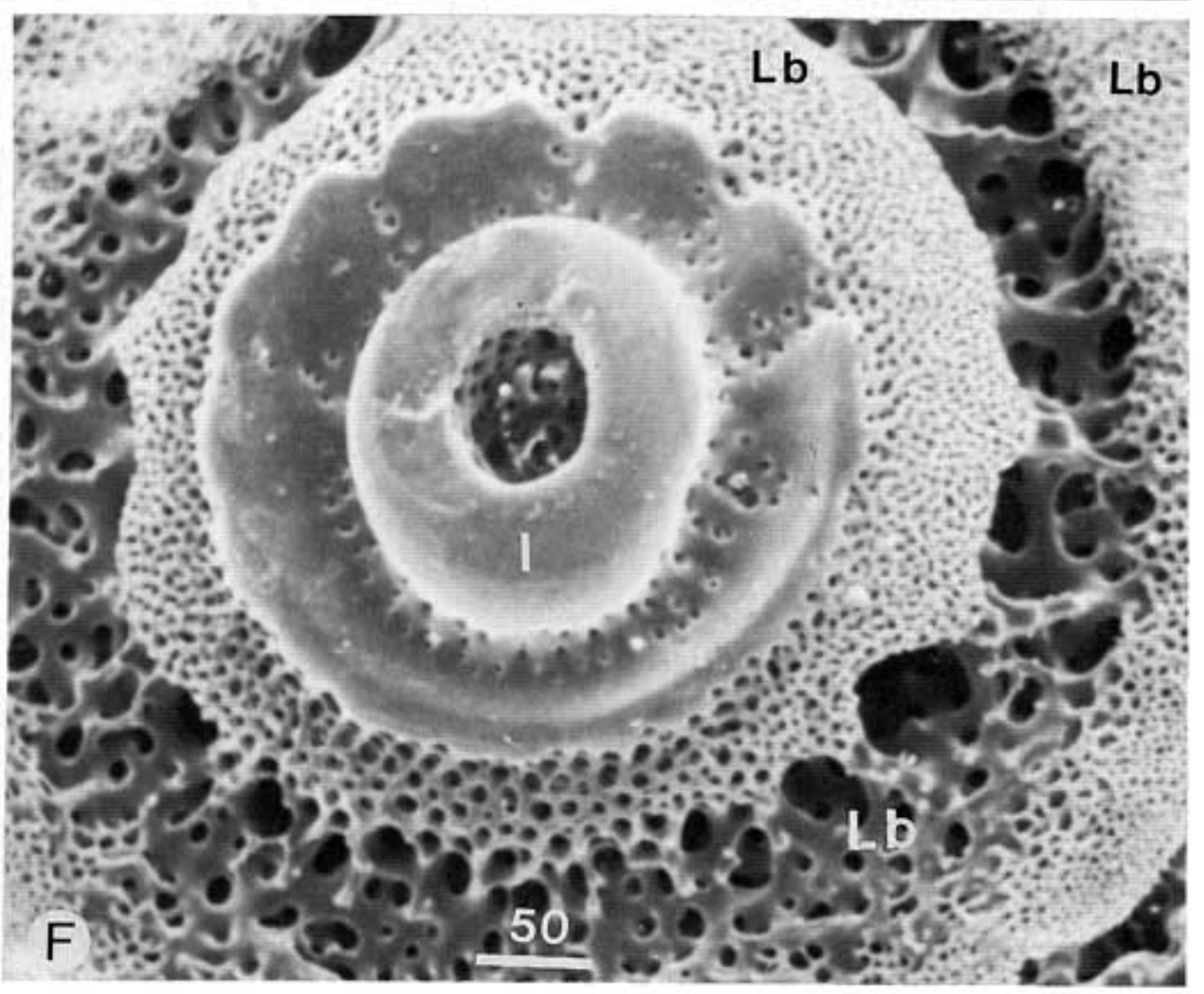
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