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# ON MICROSTRUCTURES OF COLUMNALS OF SOME PALEOZOIC CRINOIDS

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Scanning electron microscope was used to study columnals of crinoids of *Pisocrinus* (?) *costatus* (Shevchenko), *Schyschcatocrinus* sp., *Cyclocaudiculus gracilis* Głuchowski, *Rhysocamax cristata* Moore et Jeffords and *Platycrinites minor* Głuchowski from Silurian, Devonian and Carboniferous deposits of Poland. The presence of microstructures, interpreted as stereom α and stereom β have been confirmed and the occurrence of what is known as "large" microstructures on the lateral surface of the columnals of *Schyschcatocrinus* sp. have been stated. Three types within the "large" microstructures have been distinguished, the first of them marked by a close spacing of round, oval or elongated pores, the second — with round, less closely spaced pores and the third — having irregular, labyrinthic furrows and depressions.

Key words: crinoids, microstructures, Paleozoic.

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## INTRODUCTION

The skeletons of Recent crinoids are composed of many high-magnesium calcite plates of varying forms and performing various functions. These plates, hidden in mesoderm, display a strongly diversified meshlike structure (stereom) formed by a system of cross-connected rods and trabeculae. The meshes of this network are filled with tissues which connect with each other particular skeletal elements. Traces of the attachment of ligament fibers called ligament articulations (Meyer 1971; Macurda and Meyer 1975; Macurda, Meyer and Roux 1978) are visible on articular surfaces of particular elements such as brachials and stems. The elements of microstructure can be observed on a well preserved fossil material as shown by very interesting comparative studies conducted on Recent, Cenozoic and Mesozoic crinoids (Roux 1970, 1971, 1974*a*, *b*, 1975, 1977*a*, *b*, 1978; Gaspard and Roux 1974; Klikushin 1979). Several types of microstructure have been distinguished depending on the type and function of a skeletal element, as well as two main systems of the development of stereom have been settled, namely, irregular lattice and galleried stereom. The first is a three-dimensional network of irregular, labyrinthic, calcite rods with a thin meshwork of collagen microfibers (stereom β according to Roux), that is, a muscular articulation. The other is a regular galleried stereom (stereom α according to Roux) which constitutes the attachment place of collagen microfibers, that is, a ligament articulation. Similar structures may also be observed, if less frequently, on Paleozoic crinoid ossicles (Moore, Jeffords and Miller 1968; Strimple 1972, 1974; Lane and Macurda 1975; Ausich 1977).

The observations presented in this paper are based on the material from Poland. The specimens described are housed at the Center of Stratigraphy and Paleontology of the Department of Earth Sciences of the Silesian University in Sosnowiec (abbreviated as USEG).

## MATERIAL AND METHODS

The best paleontological materials for the SEM microstructural studies have been obtained from clayey and marly deposits. A meshlike structure can be exposed by etching on the surface of specimens preserved under favorable conditions. Crinoid ossicles, coming from limestones and dolomites, are as a rule already devoid of any structures and recrystallized to a considerable extent. Even the best preserved material is mostly unsuitable for studies directly after separating it from the deposit. Open spaces (pores) on the surface of a skeleton are filled by the matrix which should be removed. The best results were obtained by etching selected specimens for about 10 minutes in a 0.1 n formic acid diluted to 1 : 6 (Lapham, Ausich and Lane 1976), although the time of etching depends on the state of preservation of a fossil and frequently should be extended. The observations were made and photographs taken by means of a JEOL-35 (25 kV) scanning electron microscope.

The crinoid columnals described in the present paper were selected from among many species widely distributed over the area of Poland. The columnals of *Schyschcatocrinus* sp. come from the Givetian of the Skały Series occurring in the Grzegorzowice-Skały profile of the Holy Cross Mts. The clayey-marly deposits of this series contain a taxonomically most variable assemblage of the Devonian crinoid columnals ever found in Poland (Głuchowski 1981*a*, *b*, *c*). The columnals of *Cyclocaudiculus gracilis* Głuchowski and *Rhysocamax cristata* Moore et Jeffords come from the Tournaisian clayey intercalations in limestones outcropped at the Czatkowice quarry known for its rich benthic fauna and abundant crinoid ossicles

(Głuchowski 1980*a*, *b*; 1981*b*, *c*). *Platycrinites minor* Głuchowski come from the Namurian A dark clayey deposits of the Lublin Coal Basin (Głuchowski 1980*b*). The columnals of *Pisocrinus* (?) *costatus* (Shevchenko) represent Middle Silurian clayey deposits of NE Poland abounding in crinoid ossicles (Głuchowski *in press*, 1981*b*, *c*).

## ANALYSIS OF MICROSTRUCTURAL FEATURES

A full recognition of particular types of microstructures was not possible owing to the state of preservation of the elements of columnals described. The presence of stereom α was particularly difficult to observe since even a very accurate etching could not lead to exposing distinct structures. In the present author's opinion, the microstructures observed in some specimens, can be interpreted as a remnant of the threedimensional, parallel arrangement of galleries connected with ligament articulation (stereom α). This type of microstructure occurs, on the aerola near lumen, in *Pisocrinus* (?) *costatus* (pl. 28: 1) in which the remains of the galleries are observed on the very margin of lumen. The meshlike structure of stereom α is also observed in ligament depressions of the columnals of *Platycrinites minor* (pl. 28: 4). The remains of stereom α (pl. 27: 2 and 5) are also observed on the aerola of *Schyschcatocrinus* sp. Difficult to interpret is the microstructure of areola in *Cyclocaudiculus gracilis* since its pores, although small, rather do not resemble, in its arrangement, either stereom α or stereom β (pl. 27: 1 and 4). The size of pores in stereom α is on the whole somewhat different than that in other taxa and varies between 0.007 and 0.012 mm. Microstructures observed outside of areola, on the crenularium, indicate an irregular arrangement of pores on stereom β. Noteworthy is the fact that the structures on culmina are indistinct and show some traces of abrasion. Only those visible on crenellae are relatively well exposed (pl. 27: 1—3, 6; pl. 28: 2). Convex elements on the lateral surfaces of columnals, for example, a keel in *Rhysocamax cristata* (pl. 28: 5), also show traces of destruction. The pores of the network of stereom β are somewhat larger than those of stereom α. Their size varies in various taxa from 0.007 to 0.015 mm. This type of microstructure is connected with muscular fibers. The change from stereom α to stereom β can be sharp or gradual. The transition was observed from one to the other type on the same skeletal element (Macurda and Meyer 1975) which is indicative of the occurrence of combinations of muscular and ligament fibers. The irregular arrangement of pores, connected with stereom β, was observed in the peripheral part of columnals (crenellae) of *Cyclocaudiculus gracilis* (pl. 27: 1 and 3) and *Pisocrinus* (?) *costatus* (pl. 28: 2). Structures, observed on the lateral surface of columnals, also seem to indicate the presence of stereom β. Irregularly distributed or, sometimes, vertically extended pores (except for what is known at the "large" microstructures discussed below) were observed on the lateral surface of columnals of *Schyschcatocrinus* sp. (pl. 29: 1—6), *Pisocrinus* (?) *costatus* (pl. 28: 3) and *Rhysocamax cristata* (pl. 28: 5 and 6). The size of pores varies, therefore, mostly within a narrow range and seems to be, to a certain extent, a specific character, although detailed data on this subject may be presented only after examination of microstructures on particular stages of ontogenetic development. The results here presented (table 1) are preliminary in character.

Table 1

Dimensions of microstructural elements observed on various parts of the surface of columnals

| Species studied | size of pores mm | | |
|---|---|---|---|
| | areola | crenularium (crenellae) | side surface |
| *Cyclocaudiculus gracilis* | 0.004—0.005 | 0.007—0.010 | 0.007—0.010 |
| *Platycrinites minor* | 0.007—0.010 | — | 0.008—0.010 |
| *Rhysocamax cristata* | — | 0.008—0.010 | 0.008—0.010 |
| *Pisocrinus* (?) *costatus* | 0.008—0.010 | 0.010—0.015 | 0.008—0.010 |
| *Schyschcatocrinus* sp. | 0.008—0.010 | 0.008—0.010 | 0.003—0.010 |
| | | | 0.030—0.090 |

A particular attention is due to what is known as "large" pores observed on lateral surfaces of some columnals of *Schyschcatocrinus* sp. These elements are on the average ten times as large as the pores of stereoms α and β discussed above and three types of them may be here distinguished. Type 1 includes closely spaced pores (70—80 per cent of the surface) which are round, oval or formed as if as a result of connecting two pores adjoining each other (pl. 29: 1 and 2). Type 2 represents subcircular, deep and less closely spaced pores (30—40 per cent of the surface) than those of type 1 (pl. 29: 3 and 4). Finally, type 3 is an irregularly arranged meshwork of furrows and labyrinthic depressions (pl. 29: 5 and 6). The origin and functions of these "large" microstructural elements are unknown. Most probably, they are closely related to the dermal coating which covers the stem, since such structures are absent from articular surfaces of particular columnals. Perhaps, these pores and labyrinthic derpessions constituted the insertion of larger bundles of muscular fibers.

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EDWARD GŁUCHOWSKI

# O MIKROSTRUKTURZE CZŁONÓW ŁODYG LILIOWCÓW Z OSADÓW PALEOZOICZNYCH POLSKI

*Streszczenie*

Elementy szkieletowe liliowców paleozoicznych stosunkowo rzadko zachowują swoją pierwotną sieciową strukturę w postaci przestrzennego układu kalcytowych beleczek i pręcików (stereom). Gdy szczątki te zostaną pogrzebane w materiale gwarantującym ich bardzo dobry stan zachowania, można przy pomocy odpowiedniego preparowania struktury te obserwować wykorzystując skanningowy mikroskop elektronowy (SEM). Dla pięciu gatunków: *Pisocrinus* (?) *costatus* (Schevtschenko), *Schyschcatocrinus* sp., *Cyclocaudiculus gracilis* Głuchowski, *Rhysocamax cristata* Moore et Jeffords i *Platycrinites minor* Głuchowski z osadów syluru, dewonu i karbonu wykazano istnienie mikrostruktur interpretowanych jako stereom α i stereom β (pl. 27; pl. 28; tablica 1). Mikrostruktura ta była wcześniej obserwowana na materiale współczesnym i pochodzącym z mezozoiku i kenozoiku. Ponadto po raz pierwszy stwierdzono i opisano tzw. „duże" mikrostruktury na powierzchni bocznej *Schyschcatocrinus* sp. Podzielono je na trzy grupy różniące się między sobą budową (pl. 29). Typ pierwszy charakteryzuje się gęstym ułożeniem okrągłych, owalnych lub wydłużonych porów, typ drugi charakteryzuje się rzadszym rozmieszczeniem porów okrągłych, natomiast typ trzeci stanowią nieregularne, labiryntycznie biegnące bruzdy.

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## EXPLANATIONS TO THE PLATES 27—29

### Plate 27

### *Cyclocaudiculus gracilis* Głuchowski

Lower Carboniferous (Tournaisian), Czatkowice quarry near Cracow

1. Articular surface of a columnal, USEG 0109, ×16.5. Part shown in pl. 27: 3 is indicated by a white arrow; part shown in pl. 27: 4 is indicated by a black arrow.
3. Part of a crenularium — culmen (center) and crenellae, USEG 0109, ×132.
4. Areola and margin of lumen, USEG 0109, ×165.

### *Schyschcatocrinus sp.*

Middle Devonian (Givetian), Skały Beds, Grzegorzowice-Skały profile, Holy Cross Mts. (see also pl. 29).

2. Articular surface of columnal, USEG 0116, ×45. Lateral surface shown in pl. 29: 3 and 4 is indicated by a white arrow; parts shown in pl. 27: 5 and 6 are indicated by black arrows.

5. Fragmentary areola, USEG 0116, ×330.
6. Culmen (right side) and crenella (left side), USEG 0116, ×492.

Plate 28

*Pisocrinus* (?) *costatus* (Shevchenko)

Middle Silurian (Upper Wenlockian = Upper Bielsk), Sobotka IG-1 depth 557.6—559.7 m., Podlasie Depression.

1. Areola and margin of lumen, USEG 0102, ×246.
2. Fragmentary crenularium — culmen (center) and crenellae, USEG 0105, ×165.
3. Lateral surface, USEG 0103, ×820.

*Platycrinites minor* Głuchowski

Upper Carboniferous (Namurian A), Komarów Beds, Kosmów IG-1, depth 843.4—843.7 m., Lublin Coal Basin.

4. Fragmentary ligament depression, USEG 0104, ×492.

*Rhysocamax cristata* Morre et Jeffords

Lower Carboniferous (Tournaisian), Czatkowice quarry, environs of Cracow.

5. Lateral surface, fragmentary keel visible in the center, USEG 0111, ×246.
6. Lateral surface, the connection of two columnals is indicated by arrows, USEG 0110, ×165.

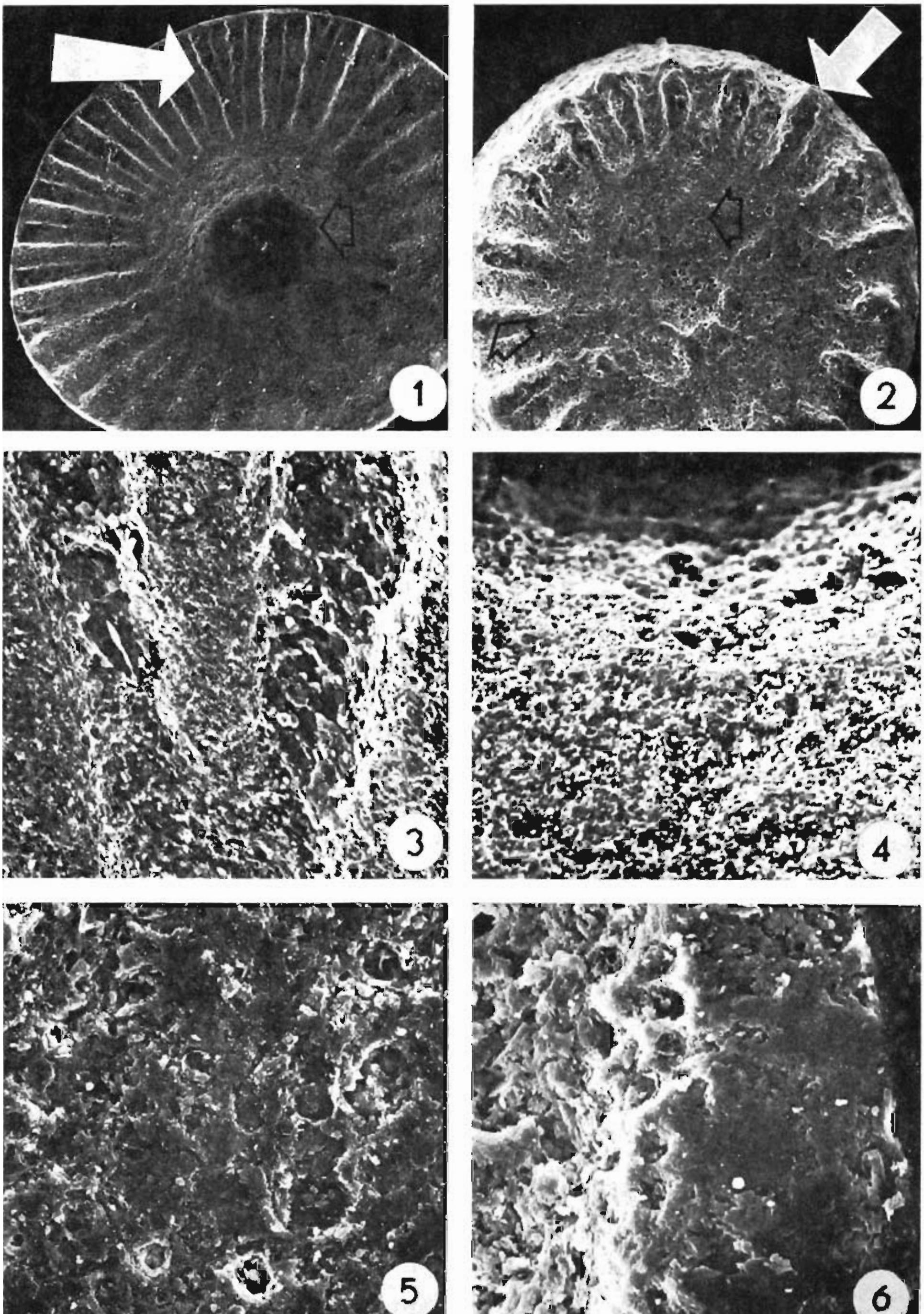
Plate 29

*Schyschcatocrinus* sp.

Middle Devonian (Givetian), Skały Beds, Grzegorzowice-Skały profile, Holy Cross Mts (see also pl. 27).

Lateral surface with "large" microstructural elements of unknown functions.

1. Round, closely spaced pores (type 1), USEG 0115, ×330.
2. Round, elongated and closely spaced pores (type 1), USEG 0124, ×443.
3. Round, widely spaced pores (type 2), USEG 0116, ×330.
4. As above, USEG 0116, ×990.
5. Irregular, labyrinthic depressions and furrows (type 3), USEG 0119, ×165.
6. As above, USEG 0119, ×330.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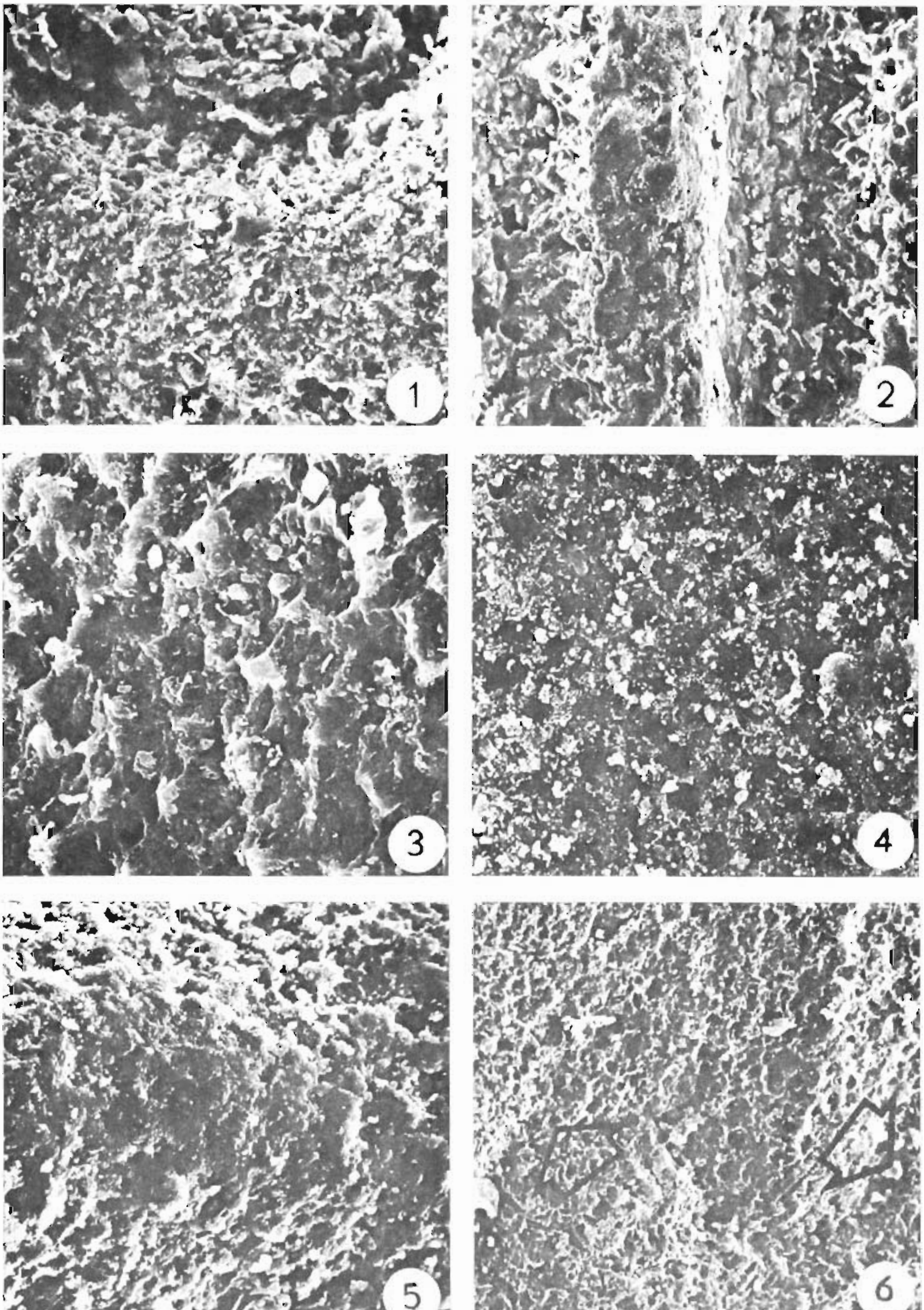
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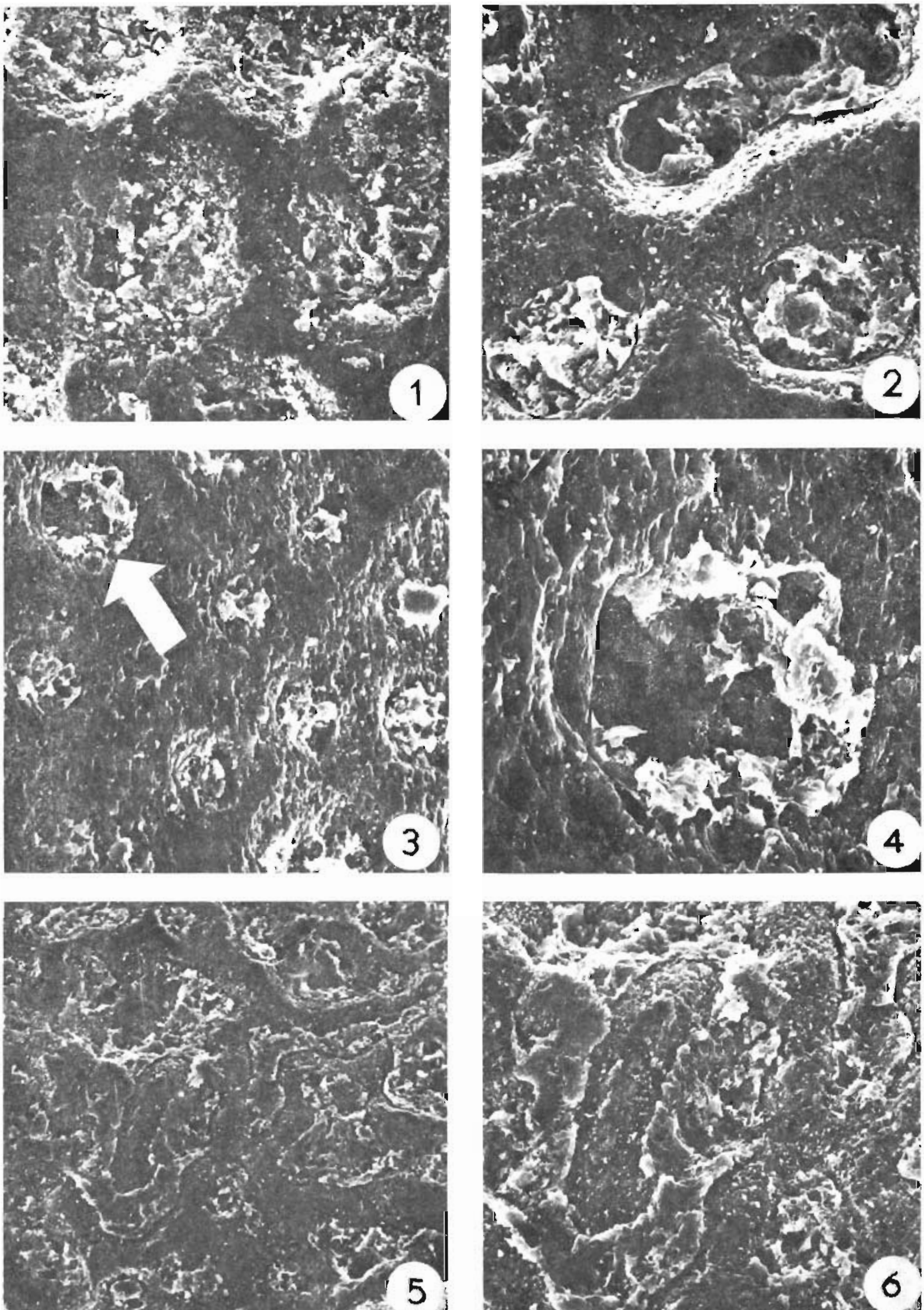
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