STROMATOPOROIDS FROM THE LATE DEVONIAN (STRUNIAN) MENGGONGAO FORMATION, CHINA

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Abstract - Five species of labechiid stromatoporoids are studied from the Late Devonian (Strunian) Menggongao Formation of central and south-central Hunan. This fauna from the Hunan province much resembles that described by Dong Deyuan (1964) from Guangxi and Guizhou. It also typically corresponds with the cool water, labechiid-rich assemblage 2 of Stearn (1987) and does not present any relation with the Strunian stromatoporoid fauna of western Europe.

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1. INTRODUCTION

Stromatoporoids are present at different levels in the Late Devonian (Strunian) Menggongao Formation of central and south-central Hunan (Fig. 1). Only a few samples (eight specimens) have been collected. They all belong to the order Labechiida, with four genera and five species of the family Labechiidae : *Labechia ?* sp., *Pachystylostroma* sp., *Stylostroma sinense* (Dong, 1964), *Platiferostroma* cf. *kwangsiense* (Dong, 1964) and *Platiferostroma ?* sp., and one species of the family Rosenellidae : *Rosenella* sp. The occurrence of five genera in eight samples clearly demonstrates the high diversity of this fauna which also typically corresponds with that of the Famennian to Strunian interval of Stearn (1979). "The most characteristic forms are the labechiids with complex pillars spreading outward from mammelon columns. Typical genera are *Stylostroma...*, *Labechia*, *Pennastroma*, and *Platiferostroma*" (Stearn, *op. cit.*, p. 230).

This fauna from the Hunan province closely resembles that described by Dong Deyuan (1964) from the neighbouring regions of Guangxi and Guizhou. Other important contributions to the study of the Late Famennian and Strunian stromatoporoids are listed by Stearn (1987) and

Figure 1 - Localities sampled in central and south-central Hunan : 1) Oujiachong, 2) Malanbian, 3) Sujiaping.

Stearn *et al.* (1987) who also discuss the palaeogeographical significance of the fauna. Three major assemblages can be distinguished :

— Assemblage 1, which consists almost exclusively of species of *Stylostroma* and *Labechia*, has been described from Novaya Zemlya, the Urals, the Russian platform, and the northern part of Western Australia (Carnarvon basin) ;

— Assemblage 2, characterized by mixed (labechiid and non labechiid) species, occurs in the Omolon area, the Donets basin, north-central Alberta, and South China ;

— Assemblage 3, without labechiids, is found in western Europe, Kazakhstan, and the southern part of Western Australia (Canning Basin).

As pointed out by Stearn (1987), the puzzling part of such a distribution is the complete absence of labechiids from assemblage 3. Referring to Lethiers (1983) and Copper (1986), Stearn and Stearn *et al.* (1987) explain this by the closure of the Palaeotethys (or Frasnian) ocean and the subsequent reorganisation of oceanic circulation. In this context, the labechiid-rich assemblages 1 and 2 are thought to have been better adapted to cool water and not able to compete with the remnant Frasnian fauna (assemblage 3) in the equatorial areas of Palaeotethys. Some parts of that scheme may be questioned in view of, for instance, Hou & Wang's palaeogeographic reconstructions (Hou & Wang, 1985). Close relationship between South China and Omolon is worth noticing, however.

The Hunan stromatoporoid fauna clearly corresponds with assemblage 2 and can more precisely be assigned to subdivision 2a of this assemblage (Stearn *et al.*, 1987) characterized by labechiid genera such as *Platiferostroma*.

2. PALAEONTOLOGY

The classification adopted in this paper is the classification proposed by Stearn (1980).

Labechia ? sp.
Pl. I, figs. 1-2; text-fig. 2

Material and occurrence : One small fragment, Sujiaping 33. Four thin sections.

External features : Small lamellar coenosteum, 3-4 mm thick, encrusting rugose coral.

Vertical section : Well expressed vertical elements (pillars), spaced 6-7 in 2 mm, ranging from 60 to 250 µm thick and up to 1 mm long or more, with rounded tops, crossing on about 4-7 horizontal cyst-plates. At the upper part of the coenosteum, pillars giving little projections in the sediment, up to 500 µm high. Horizontal elements usually represented by thin cyst-plates (30 µm thick), locally thicker (up to 100-150 µm) and spaced 8-10 in 2 mm.

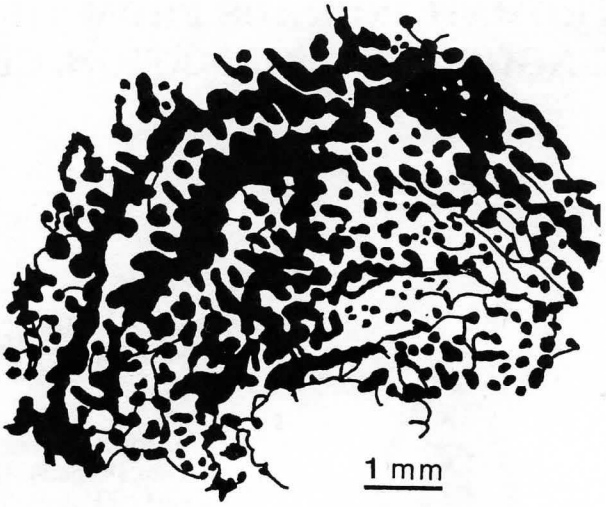

Figure 2 - *Labechia?* sp., tangential section. Specimen n° bc-33/6, Sujiaping.

Tangential section : In some parts, dots corresponding to well rounded cross sections of pillars, from 100 or less to 250 µm across and locally united in chain-like groups; but some other sections are more irregular or with very dense coenosteal tissue.

Microstructure : Coenosteal elements compact or flocculent. In vertical sections, some pillars showing an axial light rod (diagenetic feature ?).

Discussion : Rounded, long pillars that penetrate the cyst-plates indicate a *Labechia* Milne-Edwards & Haime, 1851, but the small areas in tangential section, where pillars are united in chain-like groups are rather of the genus *Labechiella* Yabe & Sugiyama, 1930

Pachystylostroma sp.
Pl. I, figs. 3-7; Pl. II, figs. 6, 9

Material and occurrence : Three specimens, Malanbian 69. Six thin sections.

External features : Small lamellar coenostea, 4-6 mm thick, encrusted by another stromato-

poroid (*Platiferostroma* sp.) and by auloporid tabulate corals. Inferior face with some large ondulations distant from about 1.50 cm. No other external features observable.

Vertical section : Coenosteal structure dominated by flat or gently convex, very thick (500-600 µm, sometimes up to 1.5-2 mm) horizontal plates, that seem to be made of several anastomosed, closely packed together elementary laminae (about 50 µm thick); in some places, where laminae are less densely packed, some dissepiments visible. Horizontal plates with flat and regularly undulated bottom but with denticulate upper surface; about 3-4 denticles by mm. Pillars very difficult to observe, but visible in some places as slightly bleached vertical zones with invagination of the tissue, localised under denticles covering the upper surface of the cyst-plates.

Tangential section : Alternating zones of different aspect: where laminae are cut, very dense zones without any void; where pillars are cut, pierced over or punctuated structure, punctuations 100-150 µm in cross-section.

Microstructure : Coenosteal elements with compact tissue.

Discussion : Denticulate, very thick horizontal elements are typical features of *Pachystylostroma* Nestor, 1964. It seems to be the first record of the genus in the Strunian of South China.

Stylostroma sinense (Dong, 1964)
Pl. I, figs. 8-10.

1964 *Pseudolabechia sinense* Dong (sp. nov.) - Dong Deyuan, p. 282, 292, pl. I, figs. 1-4.
1978 *Stylostroma sinense* (Dong, 1964) - Wang Shubei, p. 100, pl. 24, fig. 9.
1987 *Stylostroma sinense* (Dong, 1964) - Stearn *et al.*, p. 566, fig. 12.
1988 *Stylostroma sinense* (Dong, 1964) - Stearn, p. 413, figs. 3.8, 4.1-4.4, 5.6.

Material and occurrence : A single fragment, Sujiaping 39. One thin section.

External features : Sample from probably much larger coenosteum, several centimetres thick.

Internal features : Coenosteum dominated by large vesicular structure made of cyst-plates; vertical elements locally represented by only small denticles, but, in some places, complex of pillars giving mamelon columns. Size of cyst-plates highly variable : less than 0.5 to more than 15 mm wide, and 0.125 to 2.50 mm high. Thickness of cyst-plates ranging from 15 to sometimes 600 µm, with every possible transition. Often, the thickest cyst-plates, more or less irregularly spaced, covered by flat denticles (= short pillars) 350-480 µm wide and 200-450 µm high or more. Mamelon columns (with pillars) spaced about 12-15 mm, giving relief at the surface up to 4-5 mm high. Pillars generally confined to the mamelon zones, radiating outward and upward, 1800-2000 µm long and 400-500 µm wide, sometimes anastomosed.

Remark : Two different phases may be recognized, corresponding with phases 1 and 3 of Stearn (1988): phase 1, with mamelon columns constituted by pillars, and phase 3, with cyst-plates and small short pillars (denticles) only.

Microstructure : Pillars and cyst-plates with compact to flocculent tissue.

Discussion : The specimen of the Hunan province lies very close to *Stylostroma sinense* (Dong, 1964) from the neighbouring regions of Guangxi and Guizhou. It also much resembles Alberta material of Stearn (1988). Common characteristics are great variability of coenosteal structure, wide range of cysts size, and little denticles irregularly spaced on the thickest of the cyst-plates. The specimen under study just differs by some thicker cyst-plates and thicker pillars. It resembles *S. bonum* Bogoyavlenskaya, 1982 by highly variable cyst-plates dimensions, and by more or less regular zones of cysts thickening, but differs by the presence of denticles between the mamelon columns.

Distribution : Type material of *Stylostroma sinense* is from the lower part of the Shizian Formation of Guangxi. The species is also known in the lower part of the Kolaoho (= Gelaohe) Formation of Guizhou, and in the Wabamun Formation, Alberta, Canada

Platiferostroma cf. ***kwangsiense***
(Dong, 1964)
Pl. II, figs. 1-5; text-fig. 3

cf. 1964 *Stromatocerium kwangsiense* Dong, sp. nov. - Dong Deyuan, p. 285, pl. III, figs. 5-6.

Material and occurrence : A single specimen, Oujiachong 205. Two thin sections.

External features : Small nodular to lamellar coenosteum, 2.0-2.8 cm thick, growing on a colony of syringoporid.

Vertical section : Coenosteal structure with prevailing vertical elements (coenosteles); about 90 µm thick, sometimes less (60 µm) or more (up to 150 µm). Coenosteles usually thickened at the bottom, where crossing the horizontal cyst-plates. Lateral sections of coenosteles then appear like conical punctuations or denticles (villosities) put on the cyst-plates. Those vertical elements sometimes branching upward, rarely anastomosed, but in some places very regular, well defined and continuous across the structure on one centimetre or so without any change. Coenosteles regularly distributed, about 18-22 in 5 mm; spaces between them usually 200-300 µm, but sometimes up to 350-550 µm. Horizontal elements only represented by cyst-plates and scarce laminae. Cyst-plates usually plane, regular, and very thin (5-15 µm); on a level with each other, but sometimes convex or concave and often anastomosed; spaced about 12-15 in 2 mm; 15 µm thick or not much more. At some levels, thicker (45-75 µm) and more continuous horizontal elements, giving true laminae; often at the same level vertical elements more discontinuous.

Tangential section : Vertical elements rarely cut as circular dots, but more often as vermicular or irregular meandriform masses of tissue, 90-120 µm thick. Few sections of cyst-plates observable.

Microstructure : Coenosteal elements compact or flocculent.

Remark : Stearn (1980) discussed the relations between *Platiferostroma* and the Ordovician genus *Stromatocerium* Hall, 1847. He concluded that *Platiferostroma* "remains a useful name for the Strunian age" stromatoporoids.

Discussion : The specimen studied is very close to *P. kwangsiense* (Dong, 1964); it has the same general features, occurrence of denticles on the cyst-plates, and vermiform aspect of coenosteles in transversal section; the coenosteal density is just here a little higher and denticles on the cyst-plates are not so numerous. It also resembles *Platiferostroma sinense* (Dong, 1964) by high density of cyst-plates, but, in tangential section, the vertical elements of *P. sinense* are less vermicular and more meandriform. The specimen differs from *P. hybridum* (Dong, 1964) by higher density of vertical elements and by planer and more regular cyst-plates. It differs from *P. kueichowense* (Dong, 1964) by regular distribution of coenosteles in vertical section.

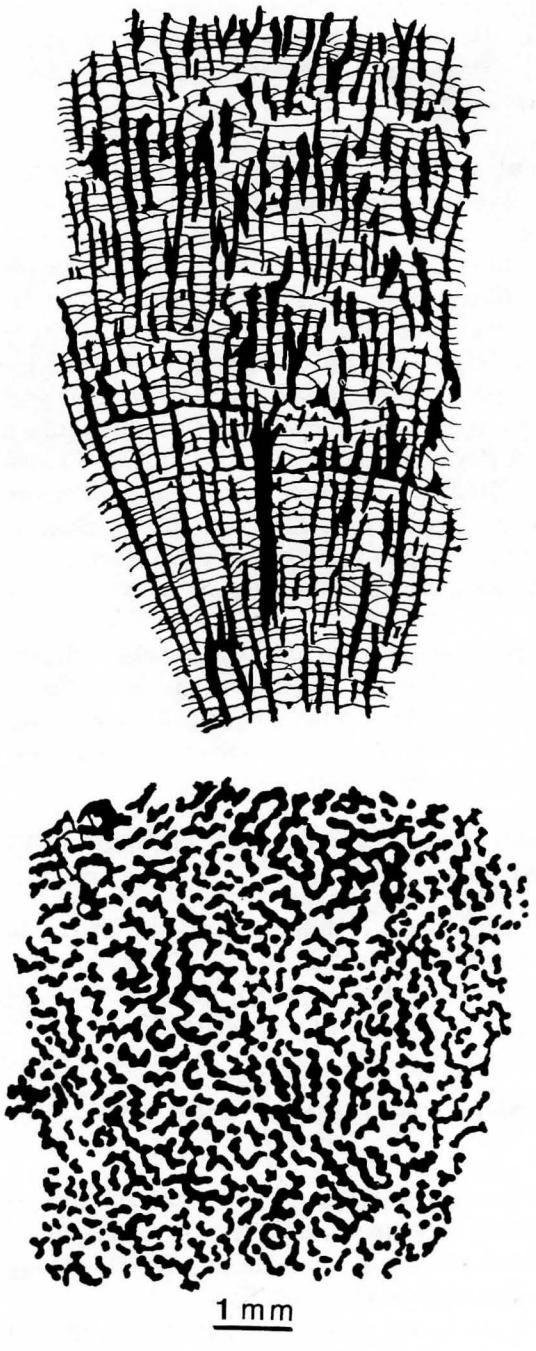

Figure 3 - *Platiferostroma* cf. *kwangsiense* (Dong, 1964), vertical (*above*) and tangential section (*below*). Specimen n° O-205/6, Oujiachong.

Platiferostroma ? sp.
Pl. II, figs. 6-9; Pl. III, figs. 1-2

Material and occurrence : Three specimens, Malanbian 69. Four thin sections.

External features : Small encrusting and very thin coenostea, 1-2 mm thick, growing on another lamellar stromatoporoid (*Pachystylostroma* sp.) and often covered by thin auloropid tabulate corals. No other external features observable.

Vertical section : Prevailing vertical elements, regularly distributed across the coenosteal structure; 26-30 in 5 mm; about 60 µm thick, but dilated at the bottom, near the contact with the horizontal elements; vertical elements coalescent in some places, reaching 200 µm thick. Horizontal elements, 8-10 in 1 mm, like thin slightly concave cyst-plates, laterally extending from the vertical coenosteles; usually on a level with each other, very thin in the centre (15-20 µm) but often thicker (up to 60 µm) near the vertical elements.

Tangential section : Coenosteal structure pierced over where coenosteles are cut; opening diameter from 60 to 100 µm, and thickness of wall 30-50 µm; but in other places, where horizontal elements are cut, more irregular and more coalescent structure with smaller and not so numerous openings.

Microstructure : Coenosteal elements compact to flocculent.

Discussion : Some characters point to *Platiferostroma* Khalfina & Yavorsky, 1973. However, very dense aspect in tangential section also points to some section of chaetetid. Nestor (1976) has suggested that the type species of *Platiferostroma*, *P. hybridum* (Dong, 1964), is a chaetetid. Nevertheless, the microstructure does not seem to be a chaetetid microstructure.

Rosenella sp.
Pl. III, figs. 3-9

Material and occurrence : Two specimens, Malanbian 100. Four thin sections.

External features : Irregularly massive coenostea, made of several lamellar, superposed and more or less anastomosed layers, 5-35 mm thick, enclosing muddy or sparitic lenses. Very large ondulations at the lower surface. No other external features observable.

Vertical section : On both specimens is it possible to distinguish two successive phases :

Phase 1 (1-1.5 mm) - Each lamellar layer beginning by an often irregular plate, about 100 µm thick, followed by a superposition of small convex cyst-plates (300-1000 µm wide and 125-250 µm high), generally thin (20-30 µm thick) but sometimes thicker (100 µm). Basal plate and some of the cyst-plates (usually the thickest) covered by irregularly spaced denticles, 60-100 µm wide and 100-300 µm high, sometimes crossing another one cyst-plate, never more; denticles more or less numerous according to the specimen.

Phase 2 (2.5-10 mm) - Only made of thin (20-30 µm thick), convex hemispheric, flattened or more irregular, superposed cyst-plates, generally larger (1000-5000 µm wide and 500-1500 µm high) than the cyst-plates in phase 1, without any denticle.

Tangential section : Mingled irregular vesicles of different dimensions, 500-1000 µm wide when phase 1 is cut, and 1000-4000 µm wide when phase 2 is passed through; in the first instance, small dots, 60-120 µm across, corresponding to the section of denticles.

Microstructure : Compact microstructure of cyst-plates and denticles. Observed in ultra-thin section cyst-plates appear to be composed of small calcite cristals (Mistiaen, 1994).

Discussion : Vesicular coenosteal structure, entirely composed of convex cyst-plates with, in some places, little denticles are typical characters of the genus *Rosenella* Nicholson, 1886. Here-studied specimens resemble *R. cyrtoformis* Li, 1982 but the cyst-plates of this species are considerably smaller. Phase 1, with denticles, closely resembles phase 3 of *Stylostroma sinense* (Dong, 1964).

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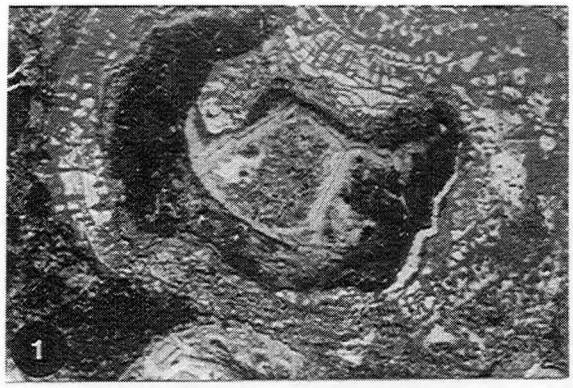
Continued on page 152

PLATE I

Figs. 1-2 *Labechia* ? sp.
1 - Specimen n° bc-33/6 (Sujiaping). Small coenosteum growing around a rugose coral fragment, x 5.
2 - *Id°*. Detail, x 30.

Figs. 3-7 *Pachystylostroma* sp.
3 - Specimen n° M-69/1 (Malanbian). Vertical section, x 15.
4 - *Id°*. Detail, x 30.
5 - *Id°*. Detail of the top of a latilamina with some pillars slightly bleached in the axial part, x 30.
6 - *Id°*. Tangential section, x 5.
7 - *Id°*. Detail, x 25.

Figs. 8-10 *Stylostroma sinense* (Dong, 1964)
8 - Specimen n° bc-39/18 (Sujiaping). Vertical section, x 5.
9 - *Id°*. Detail of another place, x 15.
10 - *Id°*. Detail of cyst-plates with flocculent microstructure, x 150.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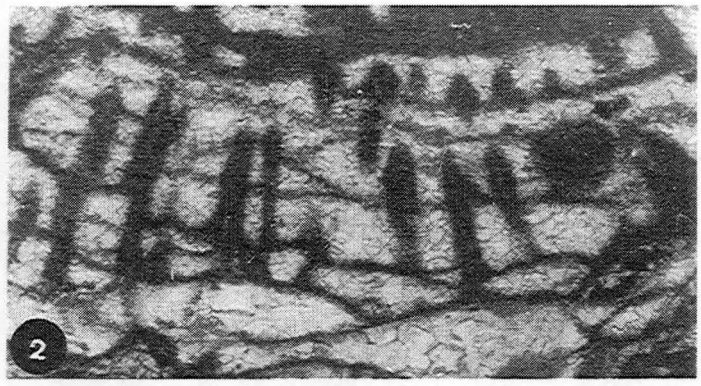
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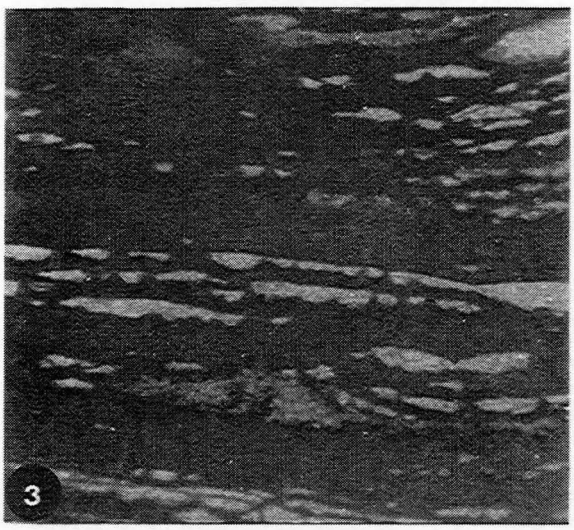
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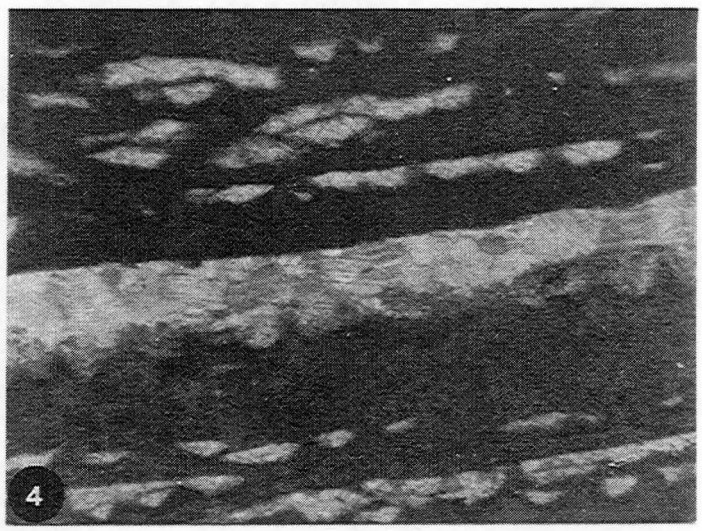
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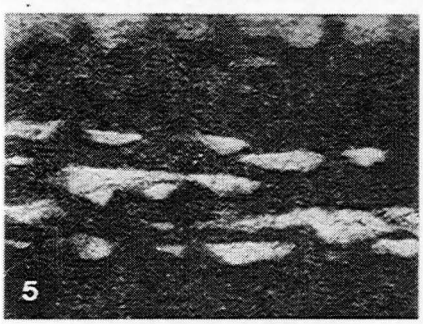
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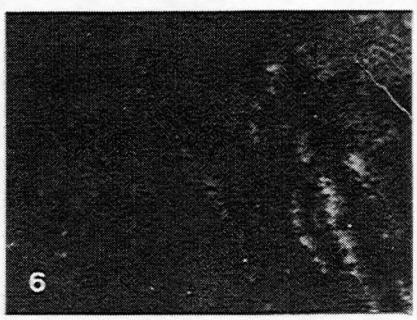
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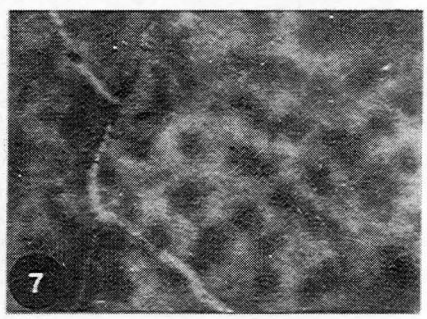
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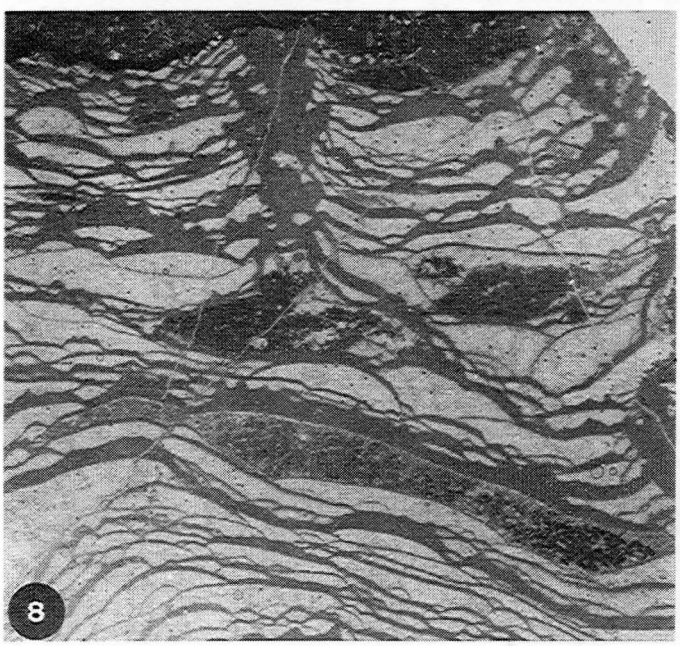
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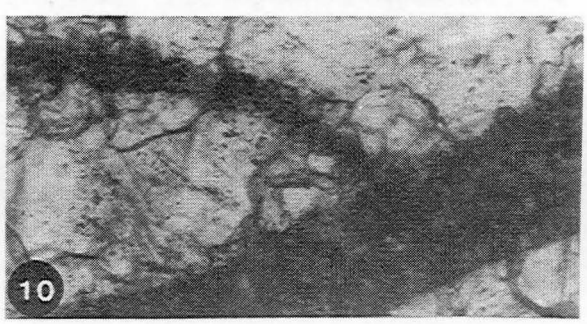
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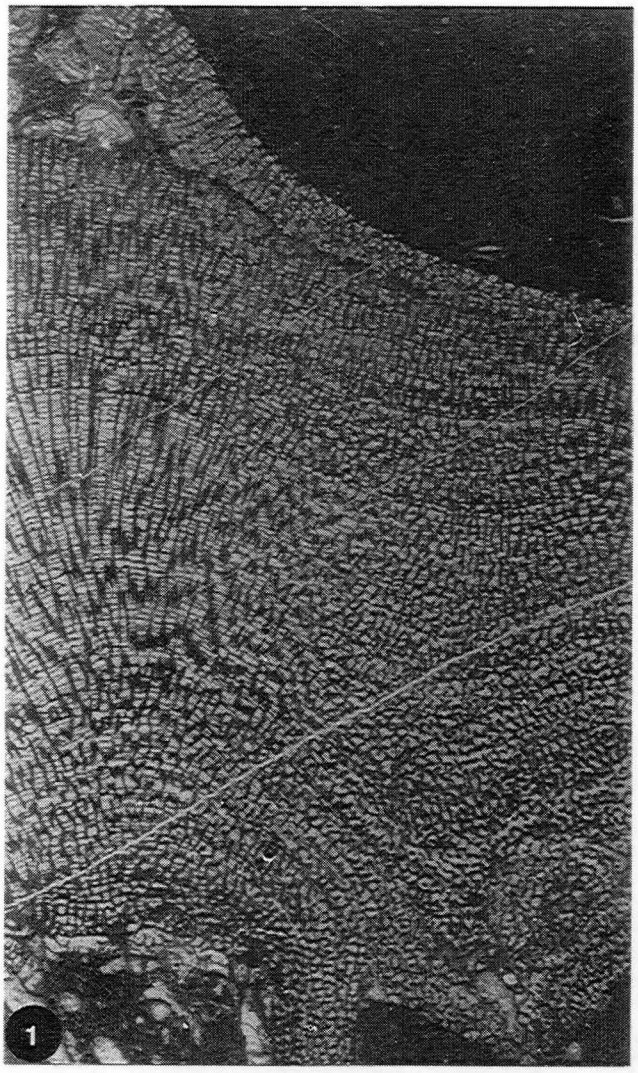
PLATE II

Figs. 1-5 *Platiferostroma* cf. *kwangsiense* (Dong, 1964)
1 - Specimen n° O-205/6 (Oujiachong). Vertical and oblique section, x 5.
2 - *Id°*. Detail, x 30.
3 - *Id°*. Tangential section, x 5.
4 - *Id°*. Detail of the vermiform structure well conspicuous, x 30.
5 - *Id°*. Microstructure in tangential section, x 150.

Figs. 6-9 *Platiferostroma* ? sp.
6 - Specimen n° M-69/1 (Malanbian). Small coenosteum encrusting *Pachystylostroma* sp. Vertical section, x 4.6.
7 - *Id°*. Detail, x 30.
8 - Specimen n° M-69/6 (Malanbian). Vertical section in a more irregular coenosteum, x 30.
9 - Specimen n° M-69.5 (Malanbian). Tangential section, x 5.
N.B. the very dense structure on the left and the right sides of the pictures is a tangential section of *Pachystylostroma* sp.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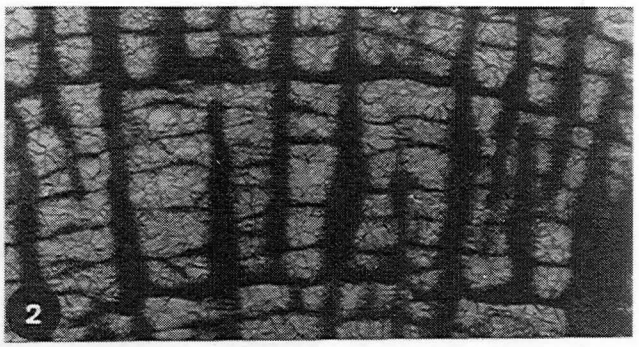
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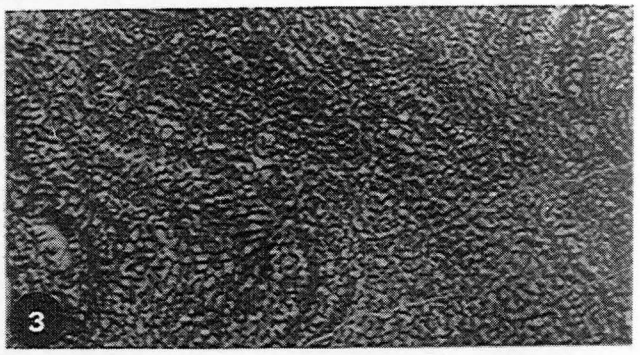
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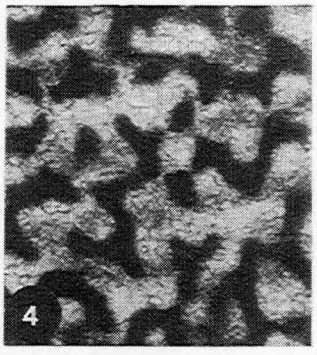
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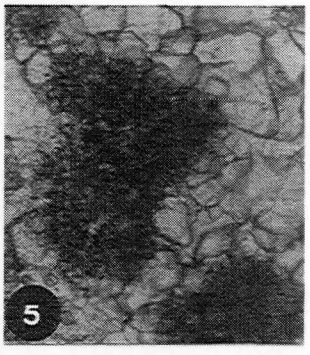
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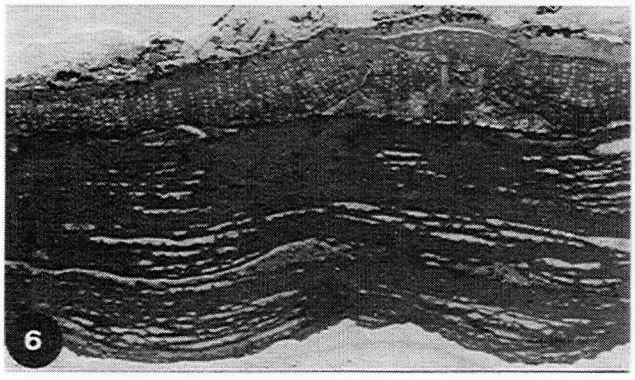
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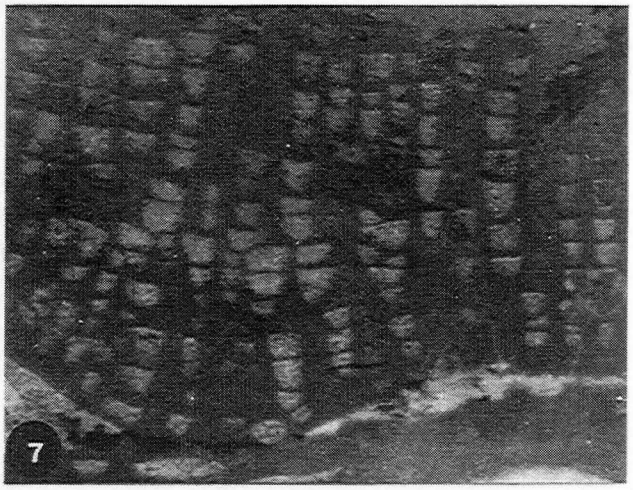
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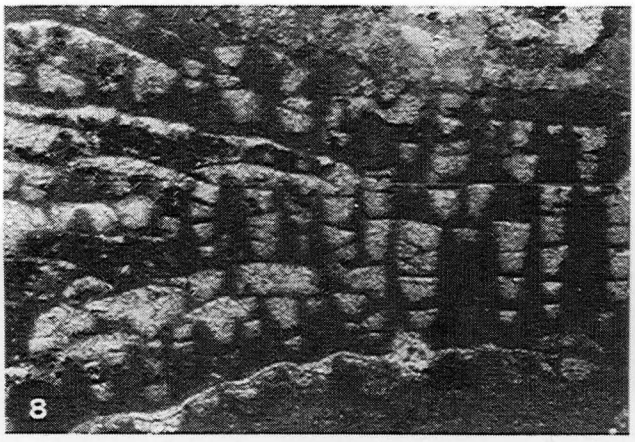
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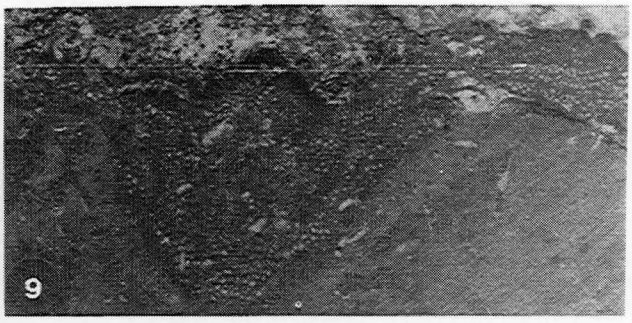
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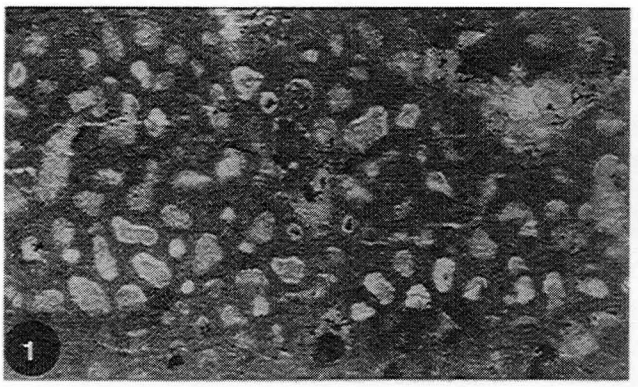
PLATE III

Figs. 1-2 *Platiferostroma* ? sp.
1 - Specimen n° M-69/5 (Malanbian). Tangential section, x 30.
2 - *Id°*. Microstructure, x 150.

Figs. 3-9 *Rosenella* sp.
3 - Specimen n° M-100/1 (Malabian). Vertical section with few denticles. Vertical section, x 5.
4 - *Id°*. Detail, x 28.
5 - Specimen n° M-100/2 (Malanbian) with more frequent denticles. Vertical section, x 4.6.
6 - *Id°*. Detail with denticles, x 25.
7 - Specimen, n° M-100/1 (Malanbian). Tangential section, x 5.
8 - *Id°*. Detail with section of denticles, x 30.
9 - *Id°*. Ultra-thin section of a cyst-plate, x 180.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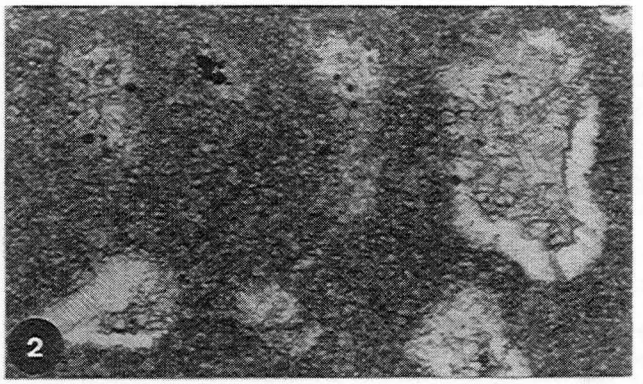
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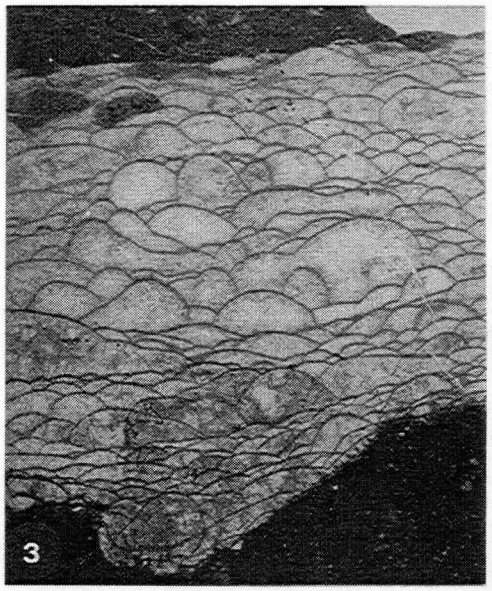
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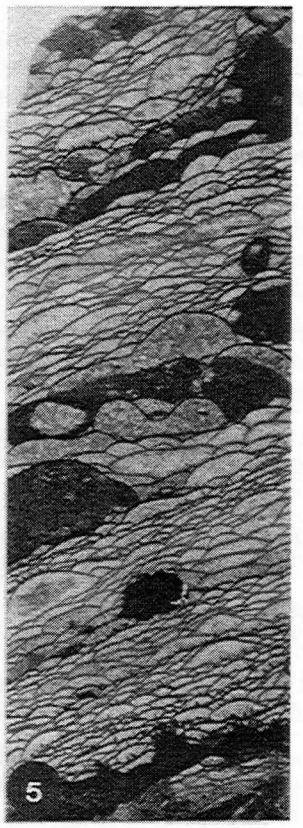
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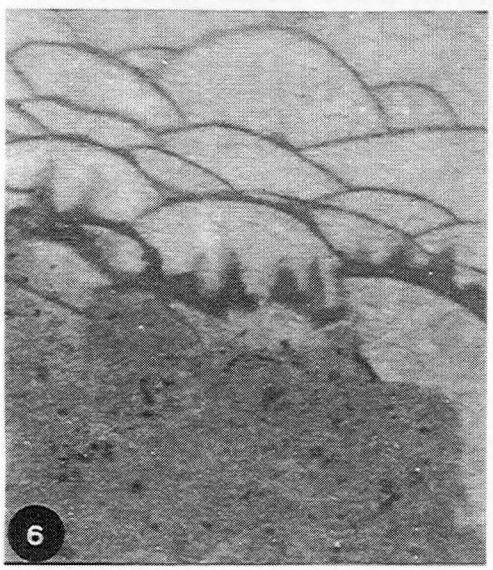
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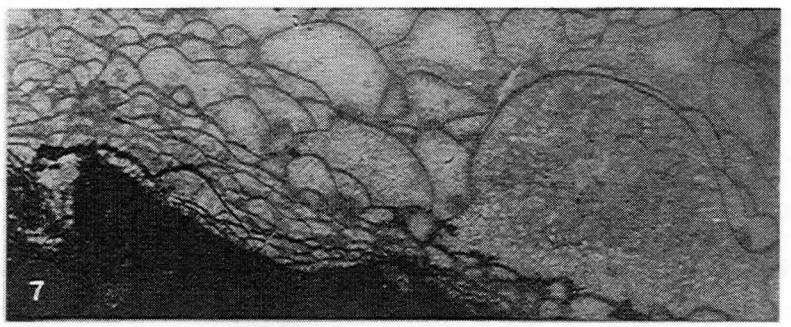
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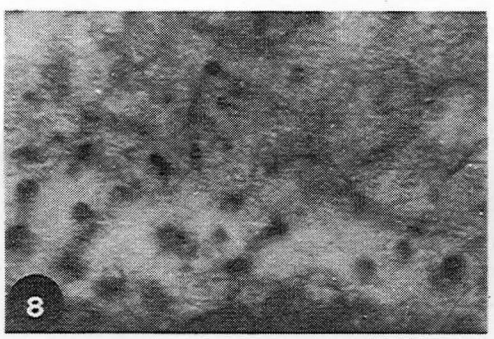
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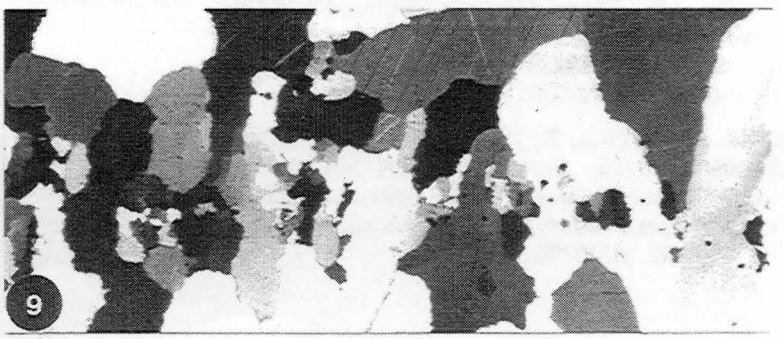
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