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Permian bryozoans from the exotic formations in Oman

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Abstract. Thirty bryozoan species in nineteen genera are described from the exotic formations in Oman. The bryozoans include one new species, *Rugofenestella omanica*, eighteen previously described species and eleven indeterminable species. These bryozoan faunas indicate an early Murgabian to early Midian age (Permian). They show relationships to bryozoan faunas of the northern, central, and southern Tethyan realm.

Key words: Bryozoans, Exotic formation, Oman, Paleontology, Permian

Introduction

Permian bryozoan faunas in the Middle East are still poorly known. Pillevuit (1993), engaged in a geological field survey of the exotic formations in Oman, studied and sampled autochthonous, para-autochthonous and allochthonous Permian to Cretaceous units in the Oman Mountains. He collected many different Permian fossils. Some brachiopods were described by Yanagida and Pillevuit (1994), some trilobites by Becq-Giraudon and Pillevuit (1995), and some cephalopods by Niko, *et al.* (1996). The present study identifies the bryozoan fauna and extends our knowledge of the distribution and paleogeographic relations of Permian bryozoans in the Middle East.

Geological Setting

The Oman mountains are composed of five main structural units (Glennie *et al.*, 1974) as follows:

1) The Autochthonous A and B units form the lowest outcropping tectonic units in Oman. The Autochthonous A is composed of folded Proterozoic to Paleozoic rocks, and the Autochthonous B is composed of Permian to Cretaceous carbonate platform and deeper-water marine sediments, typical of the southern Neotethyan passive margin.

2) The Sumeini Nappe is represented by Neotethyan slope deposits of Permian to Cretaceous age.

3) The Hawasina Nappes are subdivided into six groups comprising Permian to Cretaceous sediments; they are the Ramaq Group (Pillevuit, 1993), the Al Buda'ah Group (Pillevuit, 1993), the Hamrat Duru Group (Glennie *et al.*, 1974; Béchennec, 1988; Béchennec *et al.*,1992b), the Kawr Group (Béchennec, 1988; Béchennec *et al.*, 1992b; Pillevuit, 1993) and the Umar Group (Béchennec, 1988). Each group is defined by lithologic, sedimentologic and biostratigraphic criteria. They were derived from part of the Neotethys, which we refer to here as the Hawasina basin (Béchennec, 1988), and transported onto the Arabian margin during the Late Cretaceous (Campanian-Maastrichtian) obduction of the Semail ophiolite.

4) The Semail ophiolite is composed of a thick Cretaceous oceanic lithospheric slab.

5) The Mesoautochthonous unit is composed of a platform sequence ranging from Campanian-Maastrichtian to Miocene age, overlying unconformably the older units. This sedimentary sequence postdates the obduction of the Semail ophiolite.

The bryozoans were collected from all units except the Mesoautochthonous unit and the Semail ophiolite.

Bryozoan Localities and their Faunas

The detailed geological sequence at each locality (Figure 1) is described in Pillevuit (1993) and Pillevuit *et al.* (1997, MS). In the following list, an asterisk(*) denotes described and illustrated species in this report (Table 1).

Wadi Tayin (Samples 60-64); Lat. 23°03′10″N, Long. 58°17′50″E

The samples examined in the present article are from a 10m-thick limestone block of Permian age. This block belongs to a series of breccia exposed along the road of the Wadi Tayin, some 10 km to the east of the bifurcation from the Muscat-Sur road. According to Béchennec *et al.* (1992a, in map), this unit of breccia belongs to the Matbat Formation and is considered to have been deposited during the Triassic Period.

60- Fragments of fenestellids: *Polypora*? sp.

61- Fragments of fistuliporids: *Fistulipora*? sp., associated with fusulinaceans (*Pseudofusulina, Verbeekina, Neoschwagerina, Codonofusiella*)

64- Fragments of Goniocladiidae: *Goniocladia*? sp., associated with fusulinaceans (*Minojapanella*)

Table 1. Distribution of the described bryozoans from the exotic formations in Oman.

Locality / Species	Wadi Maqam					Nackl	Qarari	Fath	
	479	484	497	498	499	631	1028	1620	1621
Fistulipora cf. *F. wanneri*	○								
Eridopora parasitica							○		
Hexagonella kobayashii	○					○			
Goniocladia timorensis	○								
Dyscritella tenuirama	○								
Dyscritella sp. *indet.*						○			
Paralioclema eplicatum								○	○
Rhombopora aff. *R. lepidodendroides*	○								
Rhombopora sp. indet.	○								
Streblascopora delicatula	○	○				○			
Streblascopora exillis	○	○							
Timanodictya cf. *T. dichotoma*			○	○					
Girtypora cf. *G. ramosa*					○				
Alternifenestella cf. *A. horologia*	○								
Alternifenestella sp. indet. A	○								
Alternifenestella sp. indet. B	○								
Alternifenestella sp. indet. C	○								
Alternifenestella sp. indet. D	○								
Minilya duplaris	○								
Minilya sp. indet.	○								
Laxifenestella lahuseni	○								
Fabifenestella subpermiana	○								
Rugofenestella basleoensis	○								
Rugofenestella omanica, n. sp.	○								
Penniretepora sp. indet.	○								
Septopora sp. indet.	○								
Polypora cf. *P. elliptica*	○								
Polypora cf. *P. gigantea*	○								
Polypora sp. indet.	○								
Protoretepora ? sp. indet.						○			

Jebel Qamar (Samples 1507-1508 and 355-415)

The samples from Jebel Qamar belong to the Permian Qamar Formation of the Ramaq Group. The Ramaq Group is an allochthonous unit of the Hawasina Nappes and interpreted as a tilted block of the Oman margin of Permian age.

Jebel Qamar South section 1 (Samples 1507-1508); Lat. 25°43′32″N, Long. 55°53′50″E

1507- *Fistulipora* sp., *Ramipora* ? sp., *Polypora* ? sp.

1508- *Fistulipora* ? sp., *Streblascopora* sp., "Fenestellid" sp.

Jebel Qamar South section 6 (Samples 355-369); Lat. 25°42′48″N, Long. 55°54′23″E

355- *Pseudobatostomella* sp., *Rhombopora* ? sp., "Fenestellid" sp.

359- *Dyscritella* sp.

369- *Dyscritella* sp.

Jebel Qamar South section 7 (Samples 375-379); Lat. 25°42′48″N, Long. 55°53′43″E

375- *Hexagonella* ? sp., "Fenestellid" sp.

376- "Fenestellid" sp.

379- "Fenestellid" sp.

Jebel Qamar North (Samples 412-415); Lat. 25°42′48″N, Long. 55°54′08″E

412- *Rhombopra* ? sp., *Streblascopora* ? sp., "Fenestellid" sp., *Penniretepora* sp.

413- *Dyscritella* sp. "Fenestellid" sp., *Polypora* sp.

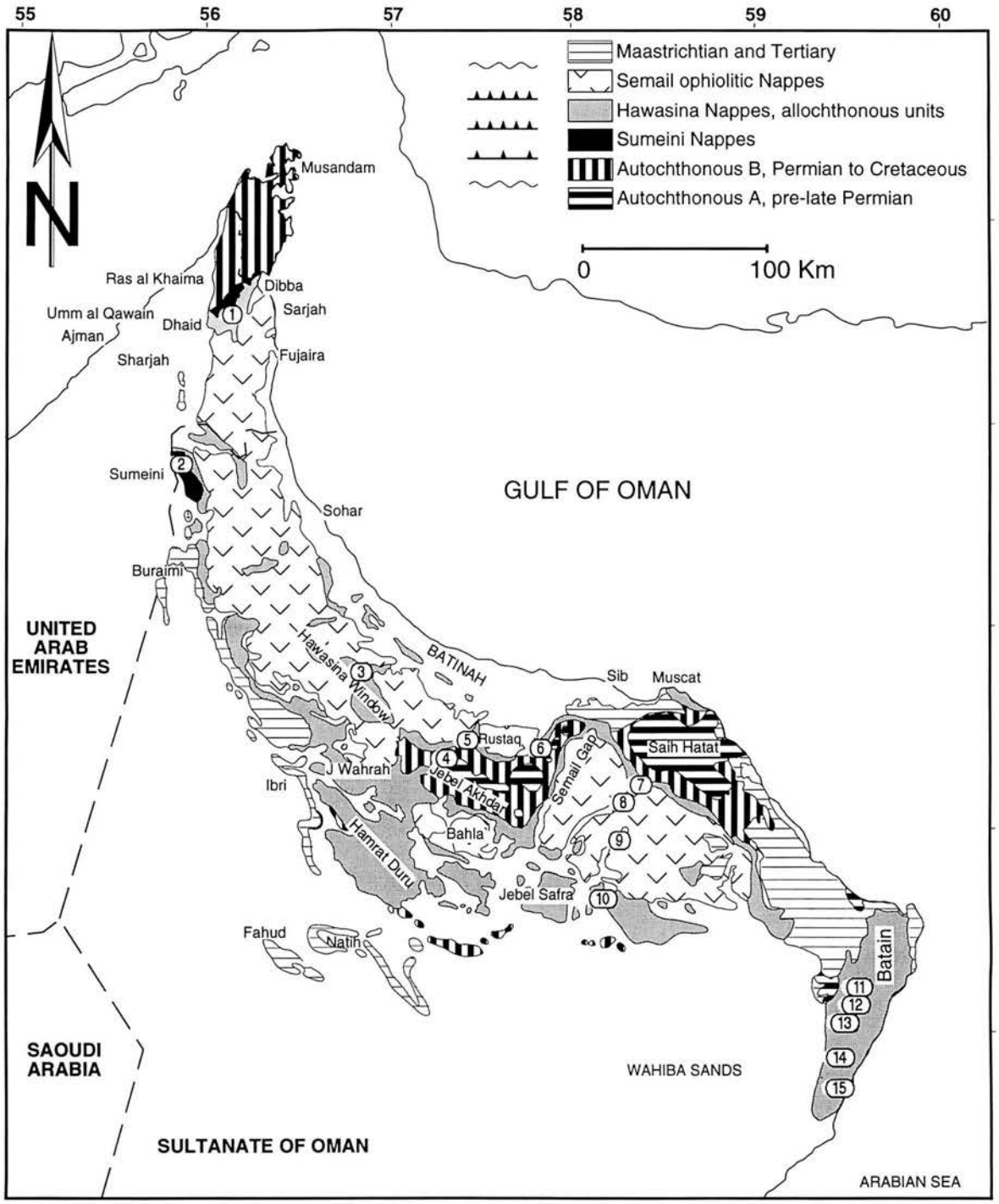
414 "Fenestellid" sp.

415- *Dyscritella* ? sp. "Fenestellid" sp., *Polypora* sp.

Wadi Maqam (Samples 479-499); Lat. and Long. not exactly.

The samples from Wadi Maqam are from the Member A of the Maqam Formation (Watts, 1985) that corresponds to the base of the Sumeini Group (Watts, 1985; Pillevuit, 1993). This member begins with 70 to 80 m of black dolomitized schists followed by grey-colored limestones bearing spicules and ostracods.

These limestones are interbedded with nodular marls, argillaceous beds, and more rare beds of bryozoan- and echinoid-bearing calcirudites. The upper part of this member is composed of grey decimetric limestones interstratified



① Jebel Qamar South and North
② Sumeini Wadi Maqam
③ Lihban
④ Wadi Sahtan
⑤ Rustaq West
⑥ Nackl
⑦ Jebel Rahbah
⑧ Wadi Wasit and Wadi Tayin
⑨ Wadi Musjah
⑩ Fath
⑪ Locality A37
⑫ Locality A39
⑬ Locality A36 and Locality A32
⑭ Jebel Qarari and Locality 941
⑮ Locality 754 and Locality A10

Figure 1. Geological map of the Oman Mountains region, showing the localities of bryozoan faunas.

with argilaceous beds. The limestones include some ammonoids and trilobites indicative of Murgabian age (Becq-Giraudon and Pillevuit, 1995).

∗479- *Fistulipora* cf. *F. wanneri, Hexagonella kobayashii, Goniocladia timorensis, Dyscritella tenuirama, Rhombopora* aff. *R. lepidodendroides, Rhombopora* sp. indet., *Streblascopora delicatula, Streblascopora exillis, Alternifenestella* cf. *A. horologia, Alternifenestella* sp. indet. A, *Alternifenestella* sp. indet. B, *Alternifenestella* sp. indet. C, *Alternifenestella* sp. indet. D, *Minilya duplaris, Minilya* sp. indet., *Laxifenestella lahuseni, Fabifenestella subpermiana, Rugofenestella basleoensis, Rugofenestella omanica*, n. sp., *Penniretepora* sp. indet., *Polypora* cf. *P. elliptica, Polypora* cf. *P. gigantea, Polypora* sp. indet.

480- *Streblascopora* sp.

∗484- *Fistulipora* sp., *Goniocladia* sp., *Rhombopora* sp., *Streblascopora delicatula, Streblascopora exillis*, "Fenestellid" sp., *Polypora* sp.

∗497- *Timanodictya* cf. *T. dichotoma*

∗498- *Timanodictya* cf. *T. dichotoma*

∗499- *Girtypora* cf. *G. ramosa*

Nackl (Samples 631-632 and 1222-1234); Lat. 23°22′40″N, Long. 57°48′50″E

The samples examined in the present article came from blocks of polygenetic breccia 20 m thick and from the overlying stratified calcarenites. This breccia mapped as the Ba'id Formation (Béchennec *et al.*, 1992b; Rabu *et al.*, 1986) is interpreted as sediments of the Permian Arabian platform redeposited at the foot of the Arabian margin (Pillevuit, 1993). Fusulinaceans such as *Yangchenia* sp., *Sumatrina* sp., and *Neoschwagerina* sp. are found in the Samples 1222-1234 and indicate Murgabian age.

∗631- *Fistulipora* sp., *Hexagonella kobayashii*? sp., *Goniocladia*? sp., *Dyscritella* sp. indet., *Rhabdomeson* sp., *Streblascopora delicatula, Protoretepora*? sp. indet. "Fenestellid" sp.

632- Fragments of Fistuliporidae, gen. et sp. indet.

1222- *Sulcoretepora* sp., *Dyscritella* sp., *Rhombopora* sp., "Fenestellid" sp.

1223- *Fistulipora* sp., *Rhombopora* sp., "Fenestellid" sp., *Polypora* sp.

1226- *Fistulipora* sp., Hexagonellidae: *Hexagonella* sp. or *Meekopora* sp., *Sulcoretepora* sp., *Streblascopora* sp., "Fenestellid" sp., *Polypora* sp.

1231- *Fistulipora* sp., *Sulcoretepora* sp., "Fenestellid" sp., *Polypora* sp.

1234- Hexagonellid gen. et sp. indet.

Wadi Wasit (Samples 665-683); Lat. 23°06′40″N, Long. 58°21′00″E

This series is characterized by the thick Upper Permian volcanosedimentary sequence composed of pillow lavas, tuffites and calcirudites of the Permian reefal limestones. All samples examined are from the blocks of limestones interpreted as being deposited at the foot of the Arabian margin (Pillevuit *et al.* 1997, MS).

665- Bryozoans indeterminable

670- Fragments of fenestellids

671- *Fistulipora* sp., "Fenestellid" sp.

672- Bryozoans indeterminable

677- Bryozoans indeterminable

683- Bryozoans indeterminable

Jebel Rahbah (Samples 1279-1280); Lat. 23°11′00″N, Long. 58°20′50″E

The samples examined are from a large block 100 m thick in a polygenetic breccia. The block is composed of fusulinaceans (*Nankinella* sp., *Verbeekina* sp., *Neoschwagerina* sp.) and bryozoan-bearing Permian platform limestones, ammonoid-bearing Triassic red limestones (Hallstatt) and volcanic rocks. The fusulinaceans indicate Murgabian age.

1279- *Streblascopora* sp., "Fenestellid" sp.

1280- *Streblascopora* sp., "Fenestellid" sp.

Wadi Sathan (Sample 1362); Lat. 23°20′00″N, Long. 57°18′50″E

This locality falls in the autochthonous units of the Jebel Akhdar. The sample is found 60 m above the transgressive unit of the Saiq Formation in Wadi Sahtan, and may be of Permian age.

1362- *Rhombopora*? sp., *Rhabdomeson* sp.

Rustaq West (Sample 1371); Lat. 23°23′46″N, Long. 57°22′28″E

This locality is situated some kilometers west of Rustaq. Lithofacies suit noted in this locality is considered a product of collapsing Permian platform into the Carnian-Norian Neotethyan basin. It is represented by a thick breccia composed mainly of the blocks of Permian platform limestones with some Triassic Hallstatt facies limestones reworked in sandstones and *Halobia*-bearing cherts of the Matbat Formation.

1371- *Fistulipora* sp.

Lihban (Sample 1587); Lat. 23°46′20″N, Long. 56°52′30″E

This locality is situated near the village of Lihban in the Wadi Hawasina. The outcrop is represented by a breccia of the Permian platform limestone overlying a thick sequence of pillow lavas and tuffites of probable Upper Permian age.

1587- *Fistulipora* sp., "Fenestellid" sp., *Polypora* sp.

Fath (Samples 1620-1621); Lat. 22°40′00″N, Long. 58°08′00″E

The locality is situated six kilometers north of the village of Fath. The outcrop is represented by an olistolith of Permian platform limestone (Murgabian) embedded in the grainstone of the Matbat Formation. The bryozoans and fusulinaceans (*Yangchenia* sp., *Chusenella* sp., *Neoschwagerina* sp., *Yabeina* sp.) are found in the limestone olistolith.

∗1620- *Paralioclema eplicatum*

∗1621- *Paralioclema eplicatum*, Bryozoans, gen. et sp. indet.

Wadi Musjah (Samples 1626-1631); Lat. 22°58′40″N, Long. 58°15′40″E.

The locality is situated in the Wadi Musjah. The samples of this section comes from blocks of Permian platform limestones in turbidites. The bryozoans and fusulinaceans (*Codonofusiella* sp., *Paraboultonia* sp., *Yangchenia*? sp., *Neoschwagerina* sp., *Yabeina* sp.) indicate Murgabian-Midian age.

1626- *Girtyporina*? sp.

1631- *Fistulipora* sp., Girtyporidae gen. et sp. indet.

Batain Jebel Qarari (Samples 1027-1033 and 1461-1462); Lat. 21°53′40″N, Long. 59°28′20″E

The locality is situated 10 km west of Al Ashkarah. This summit is a large block of Permian limestone found in association with Upper Cretaceous radiolarites and turbiditic sediments. From Beds 1027 to 1033, some fusulinaceans such as *Parafusulina* or *Pseudofusulina* are found associated with bryozoans.

1027- *Prismopora*? sp., Trepostomata, gen. et sp. indet., "Fenestellid" sp., *Polypora* sp.

*1028- *Eridopora parasitica, Hexagonella* sp., *Streblascopora* sp., "Fenestellid" sp.

1033- Fistuliporid bryozoans, *Streblascopora* sp., "Fenestellid" sp., *Penniretepora* sp., *Polypora* sp.

1461- "Fenestellid" sp.

1462- *Fistulipora* sp., *Rhombopora* sp., *Streblascopora* sp. (in association with fusulinaceans: *Codonofusiella* sp.)

Batain, Loc. 753 (Samples 1602-1604); Lat. 21°43′31″N, Long. 59°21′13″E

The locality is in the vicinity of Ras Al Jifan. The outcrop is composed of a block of platform limestones resedimented in calcarenites that overlies red radiolarites of probably Cretaceous age.

1602- *Fistulipora* sp., *Sulcoretepora*? sp., Trepostomata, gen. et sp. indet., *Streblascopora* aff. *S. diaphragma*, "Fenestellid" sp., *Polypora* sp., in association with fusulinaceans: *Boultonia* sp., *Codonofusiella* sp., Schwagerinidae gen. et sp. indet., which were noted briefly and illustrated by Sakagami (1994) in Yanagida and Pillevuit (1994). The fauna was referred to the upper Artinskian to lower Guadalupian by them.

1604- *Penniretepora*? sp.

Batain Loc. 941 (Samples 1463-1464); Lat. 21°51′08″N, Long. 59°27′44″E

This outcrop is represented by a breccia composed mainly of Permian platform limestone blocks. It overlies the grainstones of the Matbat Formation, probably indicating a Triassic age for the breccia. The constituent limestone blocks themselves contain Artinskian fusulinaceans, such as *Parafusulina* sp. and/or *Pseudofusulina* sp.)

1463- *Streblascopora* sp., "Fenestellid" sp., *Polypora* sp.

1464- *Streblascopora* sp., "Fenestellid" sp., *Polypora* sp.

Batain Loc. A10 (Sample 1731); Lat. 21°43′52″N, Long. 59°24′56″E

This outcrop is characterized by a sequence of Anisian-Ladinian radiolarite and grainstone with thinly bedded limestones overlain by a breccia of Permian platform limestone blocks containing fusulinaceans (*Parafusulina*-like), sponges, corals, bryozoans, brachiopods, crinoids. The associated fusulinaceans may indicate an Artinskian age.

1731- *Goniocladia* sp., *Dyscritella* sp., *Polypora*? sp.

Batain Loc. A32 (Sample 2506); Lat. 22°04′52″N, 59°30′38″E

The sample was collected from the limestone blocks that belong to a breccia of indeterminable age. The bryozoans, however, may indicate a Permian age.

2506- *Sulcoretepora* sp., *Rhombopora* sp., *Streblascopora* sp., "Fenestellid" sp., *Polypora* sp.

Batain Loc. A36 (Samples 2521-2531); Lat. 22°01′16″N, Long. 59°29′42″E

The samples were collected from limestone blocks that belong to a breccia of indeterminable age. The bryozoans, however, may indicate a Permian age.

2521- *Streblascopora* sp., "Fenestellid" sp.

2524- "Fenestellid" sp.

2531- *Fistulipora* sp., "Fenestellid" sp.

Batain Loc. A37 (Sample 2537); Lat. 22"12′30″N, Long. 59"34′44″E

The samples were collected from limestone blocks that belong to a breccia of indeterminable age. The bryozoans, however, may indicate a Permian age.

2537- *Goniocladia*? sp., *Rhombopora* sp., *Streblascopora* sp., "Fenestellid" sp., *Polypora* sp.

Batain Loc. A39 (Samples 2557-2566); 22°09′51″N, Long. 59°36′29″E

The samples were collected from the limestone blocks that belong to a breccia of indeterminable age. The bryozoans, however, may indicate a Permian age.

2557- Hexagonellidae, gen. et sp. indet., *Streblascopora* sp., "Fenestellid" sp., *Polypora* sp.

2566- *Rhombopora* sp., *Streblascopora* sp., "Fenestellid" sp., *Polypora* sp.

As a whole, the following 24 genera of Permian Bryozoa are identified mainly from the allochthonous formations and a few from autochthonous formations in the Oman Exotics (Permian to Cretaceous): *Fistulipora, Eridopora, Hexagonella, Meekopora*?, *Goniocladia, Prismopora*?, *Sulcoretepora, Dyscritella, Pseudobatostomella, Paralioclema, Rhombopora, Rhabdomeson, Streblascopora, Timanodictya, Girtypora, Alternifenestella, Minilya, Laxifenestella, Fabifenestella, Rugofenestella, Penniretepora, Septopora, Polypora* and *Protoretepora*.

All 18 species, except for one new and 11 indeterminable species, are common in the northern, central, and southern Tethys region. In addition, a small element of the fauna, for example *Timanodictya*, is similar to faunas on the Russian Platform and in the Uralian Sea. The bryozoans were deposited under agitated conditions because most of them are fragmentary. The present study provides an additional datum for bryozoan paleobiogeography in the Permian.

Systematic paleontology

All specimens treated in the present study are stored in the Geological Museum, University of Lausanne (MGL).

Figure 2. **1, 2.** *Fistulipora* cf. *F. wanneri* Bassler, tangential sections, MGL74509 and 74516a, respectively. **3.** *Eridopora parasitica* (Waagen and Wentzel), tangential (lower part) and oblique (upper part) section, MGL74532a. **4, 5.** *Hexagonella kobayashii* Sakagami, 4: oblique section, MGL74505c, 5: transverse section, MGL74503d. (All figures are ×20)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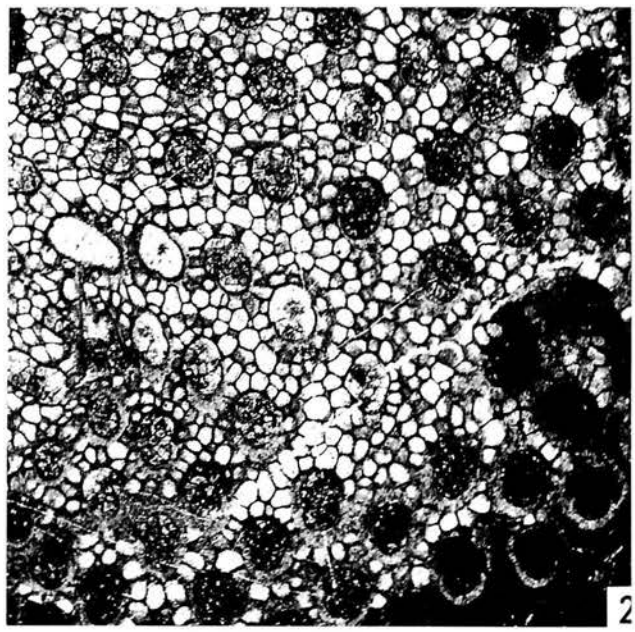
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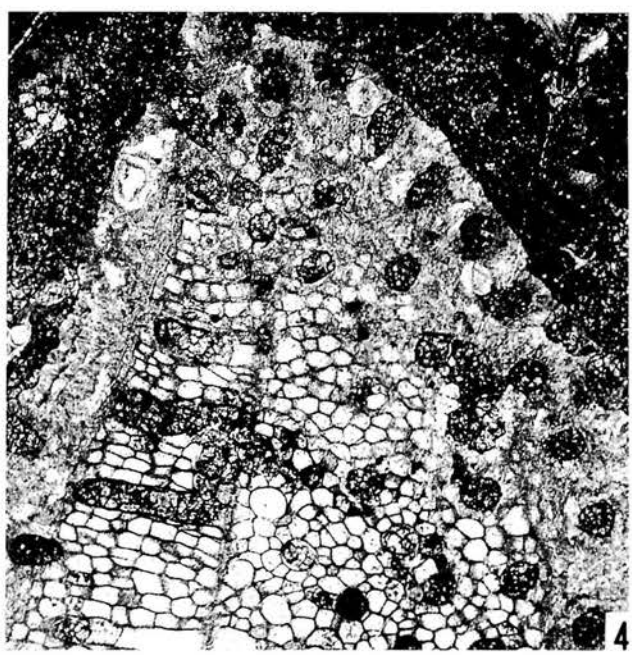
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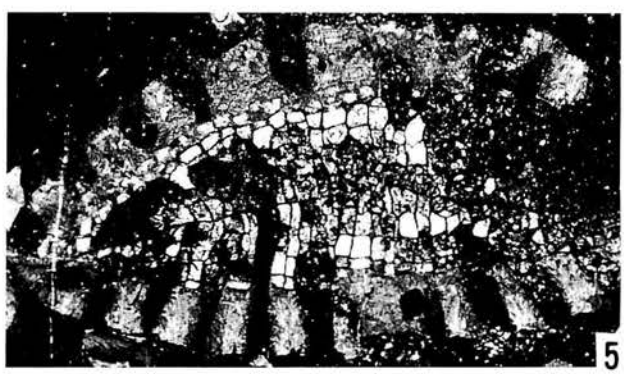
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Phylum Bryozoa Ehrenberg, 1831
Order Cystoporata Astrova, 1964
Suborder Fistuliporina Astrova, 1964
Family Fistuliporidae Ulrich, 1882
Genus ***Fistulipora*** McCoy, 1850

Fistulipora cf. ***F. wanneri*** Bassler, 1929

Figures 2-1, 2

Compared.—
Fistulipora wanneri Bassler, 1929, p. 43, pl. 233(9), figs. 1-5.

Material and Locality.—MGL74508a, 74509, 74516a (Maqam).

Description.—Only three tangential sections were examined. Shape of zoarium uncertain. Zooecial tube broadly ovate or subcircular, longer diameter excluding lunarium ranges from 0.333 to 0.500 mm and shorter diameter ranges from 0.321 to 0.358 mm. Usually 3 to 4 zooecia per 2 mm diagonally. Lunarium well developed but thin, occupying nearly one half of zooecial circumference, its thickness less than 0.030 mm. Vesicular tissue regularly arranged, usually one to three vesicles between adjacent zooecia and 6 to 8 vesicles per mm horizontally.

Remarks.—Although present only in tangential sections, the present form may be compared with *Fistulipora wanneri* described by Bassler (1929) from the Permian of Timor Island in essential characters and measurements.

Genus ***Eridopora*** Ulrich, 1882

Eridopora parasitica (Waagen and Wentzel), 1886

Figures 2-3

Fistulipora parasitica Waagen and Wentzel, 1886, p. 923, pl. 45, fig. 6; pl. 105, figs. 1-4.
Eridopora parasitica (Waagen and Wentzel), Xia, 1986, p. 232, pl. 132, figs. 8, 9, pl. 15, figs. 5, 7.
Eridopora cf. *parasitica* (Waagen and Wentzel), Sakagami, 1980, p. 273, pl. 31, figs. 7-9.
Eridopora major Bassler, 1929, p. 52, pl. 225(1), figs. 1-4; Gorjunova, 1975, p. 45, 46, pl. 3, fig. 1; Xia, 1991, p. 189, pl. 7, figs. 8, 9.

Material and Locality.—MGL74532a (Qarari).

Description.—A single tangential, partly obliquely longitudinal section shows an encrusting zoarium, in life the animal may have been attached to a foreign object such as soft body tissue.

In tangential section, zooecial tubes rounded triangular with moderately developed lunarium. Diameters of zooecial tubes becoming larger from inner to outer: inside longitudinal diameter of tubes excluding lunarium ranges from 0.256 to 0.321 mm in inner part and from 0.385 to 0.462 mm in outer part, inside transverse diameter ranges from 0.256 to 0.321 mm in inner part and from 0.385 to 0.449 mm in outer part. Usually 3.5 to 4 zooecia per 2 mm diagonally. V-shaped lunarium disposed at proximal end of zooecial tube. Thickest part of lunarium reaching 0.090 mm in outer part of zooecial tube, but very thin in inner part. A pair of small projections deposited at opposite side of lunarium in a tube. Vesicular tissue well developed, not so regular in size and arrangement, usually one to three vesicles between adjacent zooecia, and 7 to 10 vesicles per mm diagonally.

Because of the imperfect specimen, the longitudinal section cannot be sufficiently observed. Diaphragms may be abundant but the interval is indistinct. Interzooecial tissue consists of regularly arranged vesicles which are usually quadrate or scale-shaped in inner zone but are not observable in outer zone.

Remarks.—The present species was originally described from the Middle *Productus* Limestone in the Salt Range of Pakistan, and it is characterized by the existence of a pair of small projections at the opposite side of the lunarium in the tangential section of the tube. As mentioned by Sakagami (1980), such a pair of projections is also recognized in *Eridopora major* Bassler (1929) from the Permian of Timor Island. Therefore, *Eridopora major* may be a junior synonym of *E. parasitica*. The present species has been known from the Xarla Formation (Kazanian) of Xainza, Northern Xizang in China by Xia (1986) and another comparable form from the lower part of the Abadehian in the Abadeh region of Central Iran. Bassler (1929), Gorjunova (1975) and Xia (1991) described *Eridopora major* from the Permian of Timor Island, Central Pamir and Tibet, respectively.

Family Hexagonellidae Crockford, 1947
Genus ***Hexagonella*** Waagen and Wentzel, 1886

Hexagonella kobayashii Sakagami, 1968

Figures 2-4, 5; 3-1-3

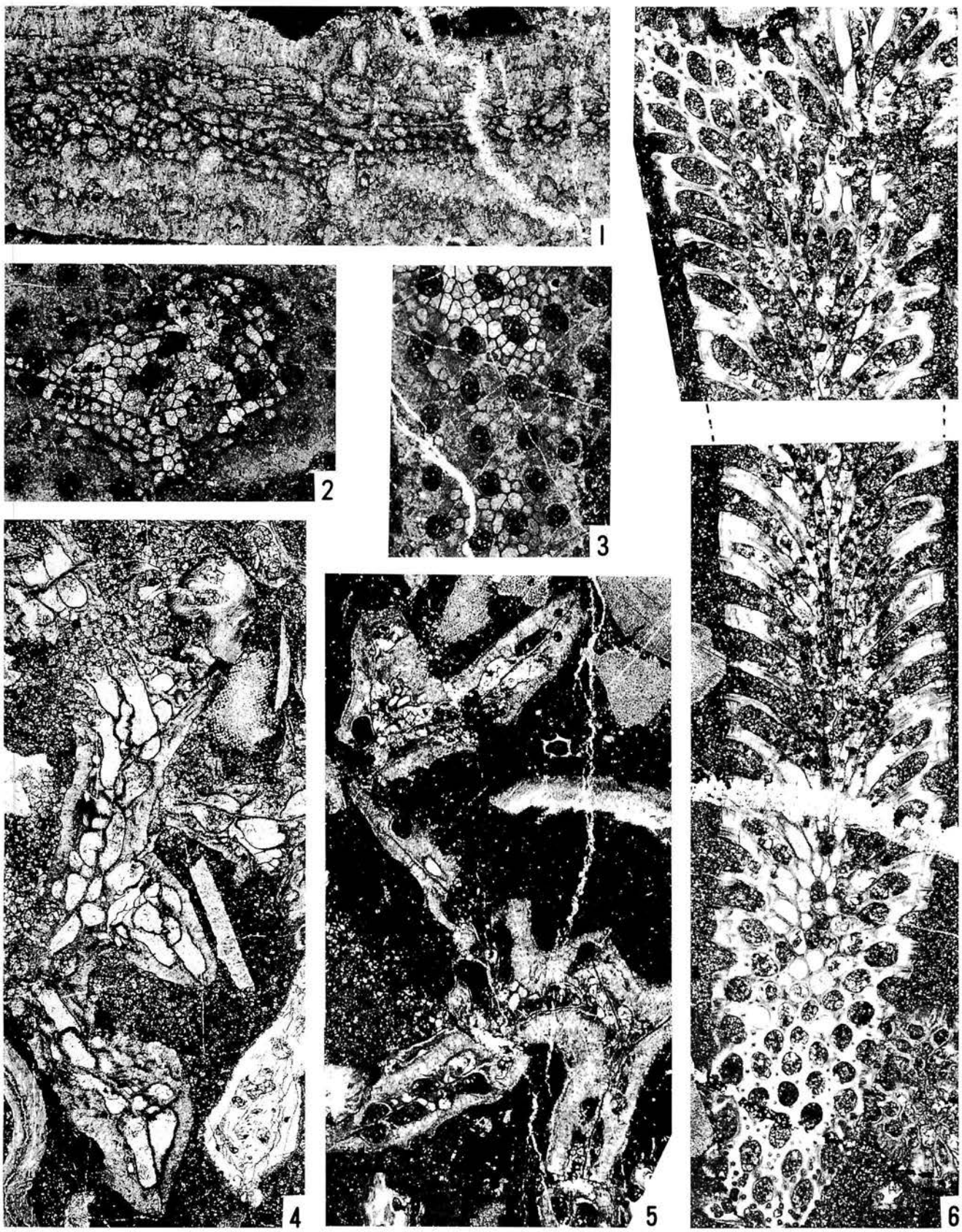
Hexagonella kobayashii Sakagami, 1968a, p. 50, 51, pl. 9, figs. 3-5.

Material and Locality..—MGL74503a, 74503d, 74505c, 74507a, 74511a, 74511b, 74513a, 74513b, 74519a, 74519b, 74522a, 74522b (Maqam); MGL74530a (Nackl).

Description.—Zoarial features only seen in thin sections, exact mode of bifurcation not known. Probably broad, parallel-sided, flattened, bifurcating frond, more than 2 mm in thickness.

In tangential section, zooecial tubes nearly circular to oval, diameter from 0.154 to 0.205 mm, occasionally 0.244 at a maximum, usually 4 to 4.5 zooecia per 2 mm diagonally. Lunarium horseshoe-shaped,occupying about one-third to one-fourth of zooecial circumference, but in many cases obliterated by secondary alteration. Interzooecial tissue fine and regularly arranged, 8 to 10 vesicles per mm horizonally in

Figure 3. 1-3. *Hexagonella kobayashii* Sakagami, 1: longitudinal section, MGL74530a. 2, 3: tangential sections (showing the hexagonellid ridges, especially in Fig. 3-2), MGL74522b and 74503a, respectively. **4, 5.** *Goniocladia timorensis* Bassler, oblique sections, MGL74520b and 74507b, respectively. **6.** *Dyscritella tenuirama* Crockford, longitudinal section, MGL74515. (All figures are ×20)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inner zone. Hexagonellid ridges are observed in thin sections cut close to the surface but their form is unknown.

In longitudinal section, zooecial tubes proximally parallel to mesotheca for a short distance, afterwards curving gradually upward and then extending directly to outer surface of zoarium at an angle of about 90°. Single diaphragm occasionally observed in inner zone of tube. Interzooecial tissue consisting of elongated quadrate vesicles arranged regularly in longitudinal series in inner zone, usually covered by dark dense fibrous materials in outer zone.

Remarks.—*Hexagonella kobayashii* was originally described from the Rat Buri Limestone cropping out at Khao Phrik near the neck of the peninsular part of Thailand. Although the surface in the present specimens is not observed, the present form can be identified with *Hexagonella kobayashii* described from Thailand by the horseshoe-shaped lunaria being relatively well developed and by its measurements. A specimen from Sample 631 in Nackl is questionably identified with *H. kobayashii*. The geological age is considered to be Middle Permian (Artinskian).

Family Goniocladiidae Waagen and Pichl, 1885
Genus ***Goniocladia*** Etheridge, 1876

Goniocladia timorensis Bassler, 1929

Figures 3-4, 5

Goniocladia timorensis Bassler, 1929, p. 89, pl. 247(23), figs. 8-15 ; Crockford, 1944a, p. 157, pl. 5, fig. 8 ; Crockford, 1957, p. 38 ; Sakagami, 1966, p. 153, text-figs. 4a, b ; Morozova, 1970, p. 80, 81, pl. 4, fig. 3.

Goniocladia timorensis var. *afghana* Termier and Termier, 1971, p. 32, pl. 16, figs. 1-9.

Material and Locality.—MGL74507b, 74520b (Maqam).

Description.—Owing to the fact that only a few fragmentary specimens were examined, zoarial form is unknown but probably consits of anastomosing branches. Branch width ranges from 0.7 to 0.8 mm. Zooecial tubes circular in tangential section near surface, diameter ranging from 0.154 to 0.179 mm, parallel to coenelasma for a short distance and curved gradually upward, meeting outer zoarial surface at an angle of about 90°. Diaphragm lacking. Interzooecial tissue consisting of vesicles in inner zone and dark fibrous material from 0.13 to 0.19 mm thick in outer zone.

Remarks.—Although these specimens are poorly preserved, the present form is quite similar to *Goniocladia timorensis* Bassler (1929) from the Permian of Timor Island in its main characters and measurements. The present species has been reported also from the Permian of Western Australia by Crockford (1944a, 1957), Thailand by Sakagami (1966), Afghanistan by Termier and Termier (1971) and Primorye region of Russia by Morozova (1970).

Order Trepostomata Ulrich, 1882
Family Dyscritellidae Dunaeva and Morozova, 1967
Genus ***Dyscritella*** Girty, 1911

Dyscritella tenuirama Crockford, 1957

Figures 3-6

Dyscritella tenuirama Crockford, 1957, p. 52, 53, pl. 13, figs. 1, 2 ; Sakagami, 1968c, p. 54, 55, pl. 8, figs. 4-8 ; Sakagami, 1995, p. 256-258, figs. 18-5, 6.

Dyscritella cf. *tenuirama* Crockford. Sakagami, 1970, p. 50, 51, pl. 7, fig. 7.

Material and Locality.—MGL74503c, 74515, 74517a (Maqam).

Description.—Zoarium slender, cylindrical ramose branches, diameter ranges from 1.9 to 2.5 mm, averaging 2.1 mm measured on 3 specimens.

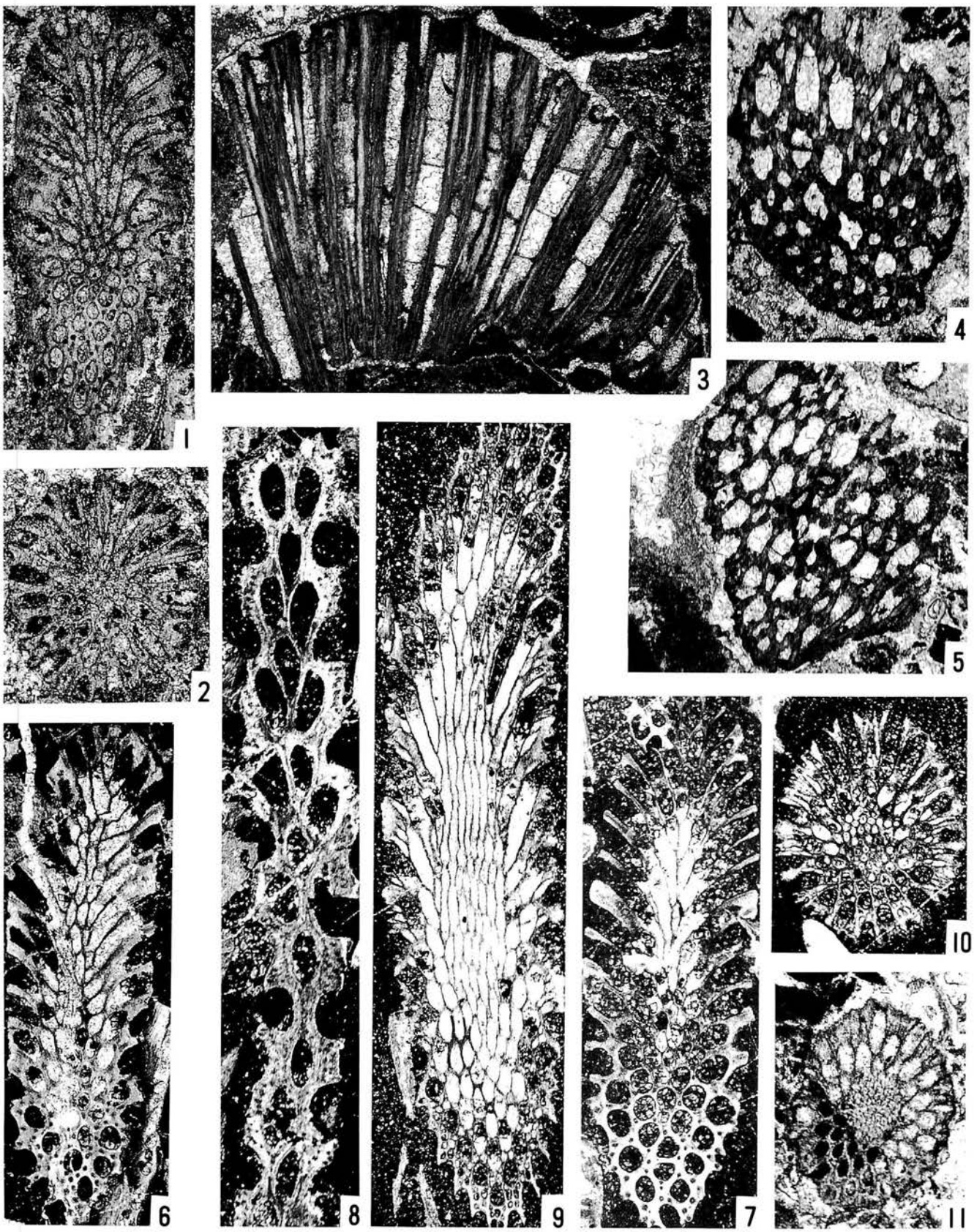
In longitudinal section, zooecial tubes parallel to longitudinal direction of zoarium in inner part of endozone, but gradually curve outward to meet outer surface of zoarium at an angle of about 90°. Zooecial walls straight, thin with a central black line in endozone, and rapidly thickening with finely laminated fibers in exozone. Diaphragms lacking.

In tangential section near the surface, zooecial apertures regularly arranged in substance in longitudinal and diagonal directions, about 3 and 4 in 1 mm in the respective directions. Zooecial tubes oval, longer diameter ranges from 0.231 to 0.282 mm ; shorter diameter ranges from 0.140 to 0.167 mm. Mesozooecia circular and rare, 0.050 to 0.070 mm. Well developed acanthostyles usually located at intersection of zooecial walls in inner part of exozone, increasing in number in outer part, surrounded by concentric dark dense fibers. Outside and inner diameters ranging from 0.050 to 0.060 mm and 0.006 to 0.010 mm, respectively.

In transverse section, zooecial tubes thin-walled, polygonal in central part of endozone. The other characters observed in transverse section are the same as in longitudinal section.

Remarks.—*Dyscritella tenuirama* was originally described from the Noonkanbah and Liveringa Formations of the Fitzroy basin, Western Australia by Crockford (1957), and later from the Permian of the peninsular part of Thailand by Sakagami (1968c, 1970) and very recently from the upper part of the Copacabana Group (*Eoparafusulina* zone) in Bolivia, South America by Sakagami (1995). The present form quite agrees with the originally described specimens from Australia in the measurements and essential characters of the internal structure.

Figure 4. **1, 2.** *Dyscritella* sp. indet., obliquely longitudinal and transverse sections, MGL74531a and 74531b, respectively. **3-5.** *Paralioclema eplicatum* Morozova, 3 : longitudinal section, MGL74534. 4, 5 : oblique sections, MGL74537 and 74533, respectively. **6, 7.** *Rhombopora* aff. *R. lepidodendroides* Meek, obliquely longitudinal sections, MGL74505a and 74505b, respectively. **8.** *Rhombopora* sp. indet., tangentially longitudinal section, MGL74506c. **9-11.** *Streblascopora delicatula* Sakagami, 9 : longitudinal section, MGL74520a, 10, 11 : transverse sections, MGL74514b and 74530b, respectively. (All figures are ×20)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Dyscritella sp. indet.

Figures 4-1, 2

Material and Locality.—MGL74531a, 74531b (Nackl).

Descriptive remarks.—Obliquely longitudinal and transverse sections examined. Zoarium slender, cylindrical ramose branches, diameter 1.6 to 1.7 mm. The present form is not unlike *Dyscritella tenuirama*, described above, but differs distinctly from the latter species by the smaller size of zooecial tubes and less developed and smaller acanthostyles. Because of the poor preservation of the thin section, specific identification must be postponed until better specimens are accumulated.

Family Araxoporidae Morozova, 1970
Genus ***Paralioclema*** Morozova, 1961

Paralioclema eplicatum Morozova, 1965

Figures 4-3—5

Paralioclema eplicatum Morozova, 1965, in Ruzhentsev and Sarycheva, p. 184, 185, pl. 25, fig. 3; Morozova, 1970, p. 135, pl. 21, fig. 4, pl. 22, fig. 1; Sakagami, 1973a, p. 69, 70, pl. 9, figs. 3-5.

Material and Locality.—MGL74533, 74534, 74535, 74536, 74537, 74538 (Fath).

Description.—Several fragments of encrusting zoarium, these may have been attached to some soft body tissue. Thickest part of zoarium reaching 5.5 mm.

In longitudinal section, zooecial tubes seem to run for a very short distance along coenelasma, then curve rapidly upward, making a right angle to surface. Usually thin and straight or slightly concave diaphragms in zooecial tubes, spaced at intervals of usually 0.30 to 0.50 mm, 4 to 5 in 2 mm length of zooecial tubes. Diaphragms in mesozooecia present but indistinct owing to poor preservation. Wall sides very smooth. Zooecial wall laminae trend approximately parallel to longitudinal direction of zooecia for a short distance before curving into zooecial boundaries. In longitudinal section of acanthoecia, laminae are sharply swelled out to surface.

In tangential section, zooecial tubes irregularly circular with polygonal margin effected by well developed acanthostyles. Diameter of zooecia 0.154 to 0.192 mm in inner zone and 0.192 to 0.231 mm in outer zone. Mesozooecia circular, commonly present, usually 0.077 to 0.103 mm, but occasionally 0.128 mm in outer zone. Acanthostyles numerous and well developed, covered with coarse concentric fibrous materials varying from 0.10 to 0.20 mm in diameter. Inside diameter of acanthostyles very small, less than 0.020 mm.

Remarks.—Except for being slightly different in the microscopic measurements, the present form is identical with *Paralioclema eplicatum*, which was originally described by Morozova (1965, 1970) from the Gnishik horizon (lower part of Guadalupian stage, Upper Permian) of Transcaucasia, Armenia, Russia, and later by Sakagami (1973a) from the upper part of the Guadalupian of Kampong Awah Quarry and Jenka Pass in Pahang, Malaya, in all of the essential characters.

Order Cryptostomata Vine, 1883
Suborder Rhabdomesina Astrova and Morozova, 1956
Family Rhomboporidae Simpson, 1895
Genus ***Rhombopora*** Meek, 1872

Rhombopora aff. ***R. lepidodendroides*** Meek, 1872

Figures 4-6, 7

Compared.—
Rhombopora lepidodendroides Meek, Newton 1971, p. 28, 29, 31-35, pl. 1, figs. 1-6, 11, 12, pl. 2, figs. 1-8, 11, 16 (see also the synonym list); Sakagami, 1995, p. 261-262, figs. 1-1-6.

Material and Locality.—MGL74505a, 74505b (Maqam).

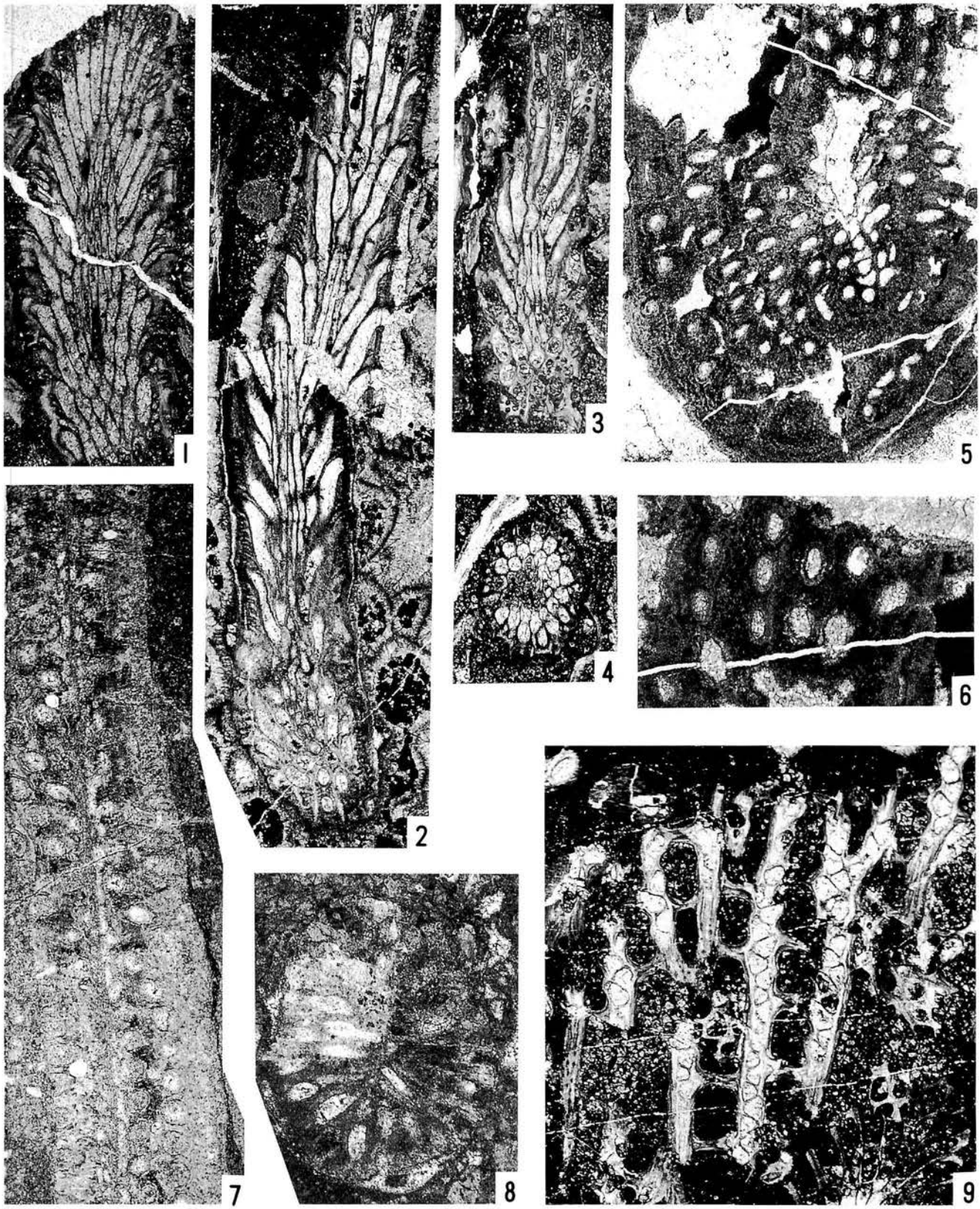
Description.—Zoarium consisting of slender, cylindrical stem, diameter 1.3 mm and 1.5 mm, respectively.

In longitudinal section, axial region consists of a nearly straight axis and straight zooecial tubes making a small angle with longitudinal direction in endozone, bending slightly and gradually outward to meet outer surface of zoarium at an angle of about 50 degrees. Zooecial walls thin and nearly straight in endozone and gradually thickened, consisting of finely laminated fibers in exozone. Diameter of endozone about 0.5 mm and width of exozone 0.4 to 0.5 mm.

In tangential section of exozone, zooecial tubes oval, longer diameter 0.192 to 0.231 mm and shorter diameter 0.141 to 0.179 mm, probably regularly arranged in longitudinal and diagonal directions; their detailed arrangement is, however, indistinct owing to badly oriented thin sections. Usually one, occasionally two acanthostyles at each corner of zooecial tube, surrounded by concentric dark fibers; outside diameter ranges varies from 0.030 to 0.060 mm, inside diameter less than 0.010 mm. Paurostyles not visible.

Remarks.—Because only two obliquely oriented thin sections are available, detailed comparisons are difficult, but the present form appears identical with *Rhombopora lepidodendroides* in essential characters. Newton (1971) discussed *R. lepidodendroides* in detail, and he concluded that its variation in time (from Early Pennsylvanian to Late Permian) and space (in worldwide distribution) lacked any systematic pattern. For the present, the Omani specimens described here are placed in a relationship of affinity.

Figure 5. **1.** *Streblascopora delicatula* Sakagami, longitudinal section, MGL74525a. **2-4.** *Streblascopora exillis* Sakagami, 2, 3: longitudinal sections, MGL74512a and 74525b, respectively, 4: transverse section, MGL74526a. **5-7.** *Timanodictya* cf. *T. dichotoma* (Stuckenberg), 5: obliquely tangential section, MGL74529, ×10, 6: enlarged tangential part of Fig. 5-5, 7: longitudinal section, MGL74528, ×10. **8.** *Girtypora* cf. *G. ramosa* Morozova, transverse section, MGL74529. **9.** *Alternifenestella* cf. *A. horologia* (Bretnall), tangential section, MGL74505d. (All figures are ×20, except for **5**-5 and **5**-7)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Rhombopora sp. indet.

Figures 4-8

Material and Locality.—MGL74506c (Maqam).

Descriptive remarks.—A single tangentially longitudinal section was examined. Zoarium consisting of nearly straight, slender, cylindrical stem, having small diameter: about 1.0 mm. The present form is not unlike *Rhombopora lepidodendroides* in general mode, but it can be distinguished from the latter species by the larger diameter of the zooecial tubes. The specific identification must be postponed until better specimens are accumulated.

Family Hyphasmoporidae Vine, 1886
Genus ***Streblascopora*** Bassler, 1952

Streblascopora delicatula Sakagami, 1961

Figures 4-9—11; 5-1

Streblascopora delicatula Sakagami, 1961, p. 52, pl. 25, figs. 7-10, pl. 26, figs. 1-18, pl. 27, figs. 1-5; Sakagami, 1973b, p. 84, 85, pl. 8, figs. 1-4; Yang and Lu, 1984, p. 53, 54, pl. 1, fig. 5b, pl. 2, figs. 3a, b.

Material and Locality.—MGL74503b, 74514b, 74516b, 74518a, 74518b, 74520a, 74525a (Maqam); MGL74530b (Nackl).

Description.—Zoarium consists of cylindrical ramose branches, varying from 1.3 to 1.9 mm in diameter.

In longitudinal section, diameter of central bundle 0.5 to 0.7 mm, ratios of zoarial diameter to central bundle ranging from 2.5 : 1 to 3.1 : 1, and number of tubes in central bundle 7 to 8. Zooecial tubes arise from central bundle at an angle of about 25°, straight in endozone and curving rapidly at inner edge of exozone. Metapores arise from base of exozone, approximately parallel to endozone wall for a very short distance, then curving rapidly outward and parallel to zooecial tubes in exozones.

In tangential section of exozone, zooecial tubes oval, longer diameter 0.154 to 0.179 mm and shorter diameter 0.090 to 0.115 mm. Zooecial apertures arranged regularly in longitudinal rows with about 4.5 zooecia in 2 mm measuring lengthwise and almost 10 in the same space transversely. Superior and inferior hemisepta may be present but are rarely observable. Metapores usually circular but irregular in shape and size, diameter ranging from 0.013 to 0.038 mm, usually two or three rows with 2 to 3 in each row longitudinally. Total number of metapores disposed between zooecial tubes in one series usually 7, occasionally 10.

In transverse section, number of tubes in central bundle were counted as more than 40 in one typical section. The other characters observed in transverse section are the same as in longitudinal section.

Remarks.—Many species included in the genus *Streblascopora* are widely distributed in the Tethys and Tasman Geosyncline provinces in Middle Permian time. Among these, the present form agrees with *Streblascopora delicatula* which was described originally by Sakagami (1961) from the Upper Permian of several localities in Japan in its essential features, especially size of zoarium and mode of central bundle. The present species is characterized and can be distinguished from the already described species by the larger diameter of the central bundle, having about 40 or more tubes. This species has been reported also from the Lower Permian (most probably late Artinskian) of the Rat Buri Limestone in Khao Raen at the neck of the peninsular part of Thailand by Sakagami (1973b) and the Maokou Formation (Permian) of Kueichou, South China by Yang and Lu (1984).

Streblascopora exillis Sakagami, 1970

Figures 5-2—4

Streblascopora exillis Sakagami, 1970, p. 64, 65, pl. 12, figs. 4-8.

Material and Locality.—MGL74511c, 74512a, 74523b, 74523c, 74525b, 74526a (Maqam).

Description.—Zoarium nearly straight, slender, cylindrical stem, 0.9 to 1.2 mm in diameter.

In longitudinal section, diameter of central bundle 0.3 to 0.5 mm, ratio of zoarial diameter to central bundle ranging from 3.0 : 1 to 4.0 : 1, and number of tubes in central bundle 4 to 6. Zooecial tubes arise from central bundle at an angle of about 20°, straight in endozone and curving rapidly at inner edge of exozone. Metapores arise from base of exozone, approximately parallel to endozone wall for a very short distance, then curving rapidly outward and parallel to zooecial tubes in exozone.

In tangential section, zooecial tubesoval, larger diameter 0.141 to 0.167 mm and shorter diameter 0.103 to 0.128 mm. Zooecial apertures arranged regularly in longitudinal rows. Number of zooecia indistinct but probably 3 to 4 per 2 mm longitudinally. Superior and inferior hemisepta seem to be undeveloped. Metapores circular and regular in shape and size, usually two rows with four to five in each longitudinal row, total number of metapores disposed between zooecial tubes in one series 8 to 10. One straight diaphragm disposed near surface of tube.

In transverse section, number of tubes in central bundle counted as nearly 10. The other characters observed in transverse section are the same as in longitudinal section.

Remarks.—The present form may be identical with *Streblascopora exillis* which was described by Sakagami (1970) from Ko Muk on the west coast of Thailand in all essential characters, especially its small zoarial diameter and number of metapores between zooecial tubes. The Ko Muk bryozoan fauna is thought to be most probably late Artinskian. The present form seems to resemble *Streblascopora biserialis* (Bassler) which was originally described by Bassler (1929) from Timor, but a detailed comparison between them is impossible, because the Timor species depends on a brief description with only one illustration of the surface of a specimen.

Suborder Timanodictyoidea Morozova, 1966
Family Timanodictyidae Morozova 1966
Genus ***Timanodictya*** Nikiforova, 1938

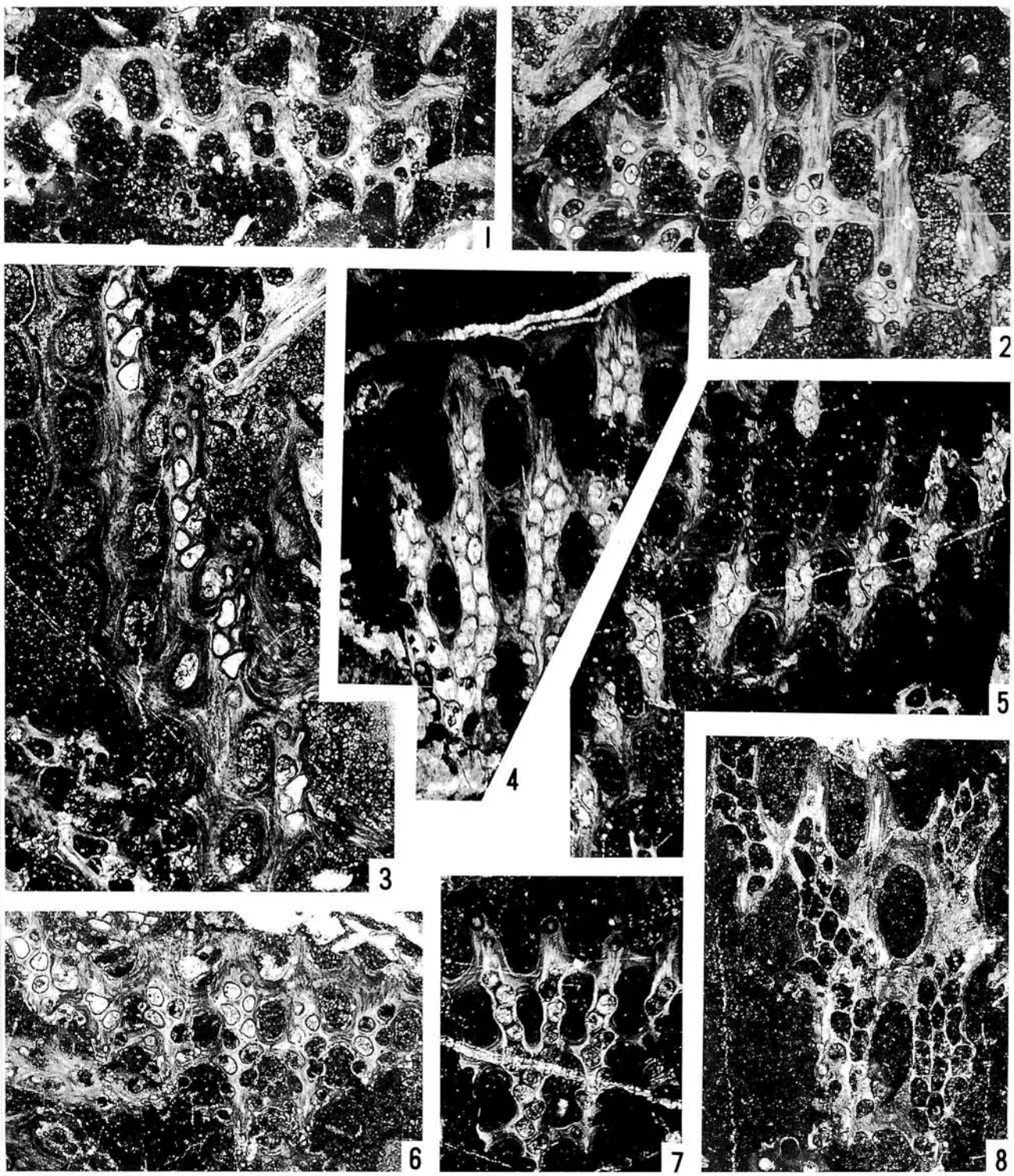


Figure 6. **1.** *Alternifenestella* sp. indet. A, tangential section, MGL74506b. **2.** *Alternifenestella* sp. indet. B, tangential section, MGL74508b. **3.** *Alternifenestella* sp. indet. D, tangential section, MGL74502. **4.** *Laxifenestella lahuseni* (Stuckenberg), tangential section, MGL74512b. **5.** *Minilya duplaris* Crockford, tangential section, MGL74517b. **6.** *Minilya* sp. indet., tangential section, MGL74524a. **7.** *Alternifenestella* sp. indet. C, tangential section, MGL74508c. **8.** *Polypora* cf. *P. elliptica* Rogers, tangential seciton, MGL74510. (All figures are ×20)

Timanodictya cf. ***T. dichotoma*** (Stuckenberg, 1895)

Figures 5-5—7

Compared.—
Coscinium dichotoma Stuckenberg, 1895, p. 173, pl. 24, fig. 3.
Timanodictya dichotoma (Stuckenberg), Nikiforova, 1938, p. 185-188, 269-271, pl. 48, figs. 1-4, pl. 49, figs. 1-10, pl. 50, figs. 1-4, pl. 51, figs. 1-6, pl. 52, figs. 5-7.
Timanodictya cf. *T. dichotoma* (Stuckenberg), Ross and Ross, 1962, p. 60-62, pl. 18, figs. 1-6.

Material and Locality.—MGL74527, 74528 (Maqam).

Description.—Only obliquely tangential and obliquely longitudinal sections were examined. Zoarium consists of broad, bifoliate branch, estimated to be about 8 mm in width and about 3 mm in thickness. The growth system is not observed in the present specimens.

In tangential section, zooecial tubes oval, usually 3.5 to 4 zooecia per 2 mm in longitudinal direction. Shorter diameter of zooecial tubes ranges from 0.128 to 0.167 mm, and longer diameter from 0.192 to 0.231 mm. Zooecial tubes surrounded by rather thick, light-colored partition. Interzooecial tissue consisting of fine, dark laminae and pierced by numerous small rods or tubes.

In longitudinal section, zooecial tubes proximally parallel to mesotheca, curved rapidly outward, and making a right angle with outer surface of zoarium.

Remarks.—Because of the secondarily altered, fragmentary specimens at hand, a detailed comparison with the type specimens of *Timanodictya dichotoma* described by Nikiforova (1938) from the '*Schwagerina*' beds (Lower Permian) of Timan, Russia is impossible. The present form, however, may be conspecific with the Timan species. The comparable species was described by Ross and Ross (1962) from the Wolfcampian ? of Holm Land, northeast Greenland.

Genus ***Girtypora*** Morozova, 1966

Girtypora cf. ***G. ramosa*** Morozova, 1966

Figures 5-8

Compared.—
Girtypora ramosa Morozova, 1966, p. 36, 37, pl. 5, fig. 2; Morozova, 1970, p. 248, 249, pl. 60, fig. 2, pl. 61, fig. 1; Liu, 1980, p. 253, pl. 111, figs. 5, 6.

Material and Locality.—MGL74529 (Maqam).

Description.—A single transverse section of zoarium was examined. Zoarium consisting of cylindrical branch, having a small diameter: about 2 mm. Zooecial tubes arise directly from median laminae to zoarial surface and range from 0.141 to 0.167 mm in diameter. Interzooecial tissue consists of dark, fine fibers with spicule-like structure.

Remarks.—Despite there being available only one transverse section of zoarium, the present form seems to be identical with *Girtypora ramosa* which was originally described by Morozova (1966) from the lower Kazanian (Upper Permian) of the Russian Platform in its essential characters, but the zooecial tubes are slightly narrower than in the Russian specimens. Accordingly, the present form is only compared with *Girtypora ramosa* although it may be conspecific with the Russian species. The present species was also described by Liu (1980) from the upper part of the Lower Permian of northeast China.

Order Fenestrata Elias and Condra, 1957
Family Fenestellidae King, 1849
Genus ***Alternifenestella*** Termier and Termier, 1971

Alternifenestella cf. ***A. horologia*** (Bretnall, 1926)

Figures 5-9

Compared.—
Fenestella horologia Bretnall, 1926, p. 15, pl. 1, fig. 6; Hosking, 1931, p. 13, pl. 4, fig. 3; Crockford, 1957, p. 57; Wass, 1966, p. 92-94, pl. 2, fig. 1, 3, not 2, 4-7; Wass, 1967, p. 16; Sa-

Table 2. Measurements of the species of *Alternifenestella, Minilya,*

Species	*Specimen No. (MGL)*	*No. per 10 mm*		*No. of zooecia*		*No. of nodes per 5 mm*
		branches (horizontally)	*fenestrules (longitudinally)*	*per 5 mm*	*per fenestrule*	
Alternif. cf. *A.horologia*	74505d	18	18	18	2	—
Alternif. sp. indet. A	74506b	18-20	16	16	2	indistinct
Alternif. sp. indet. B	74508b	16	14	14	2-3	indistinct
Alternif. sp. indet. C	74508c	18	16	16	2	indistinct
Alternif. sp. indet. D	74502	ca. 16	13	13	2-3	—
Minilya duplaris	74517b	20	18	18	2	36
Minilya sp. indet.	74524a	18	20	20	2	40
Laxif. lahuseni	74512b	16	10	ca. 20	4	indistinct
Fabif. subpermiana	74521a	12	9	18	4	indistinct
Rugof. basleoensis	74521b	13	9	18	4	—
Rugof. omanica sp. nov.	74514a, 74517c	15	8-9	16-18	4-5	16-18

kagami, 1968b, p. 69-71, text-fig. 3A.
Fenestella cf. *horologia* Sakagami, 1970, p. 55, 56, pl. 9, fig. 6.
Fenestrellina horologia (Bretnall), Crockford, 1943, p. 266 ; Crockford, 1944a, p. 158 ; Crockford, 1944b, p. 167, pl. 1, figs. 3, 6 ; Crockford, 1944c, p. 189, pl. 1, fig. 1 ; pl. 2, fig. A ;
Fenestella parviuscula Bassler, 1929, p. 76, pl. 241(17), figs. 8-13 ; Fritz, 1932, p. 99 ; Elias, 1937, p. 314.

Material and Locality.—74505d (Maqam).

Description.—A single tangential section. Zoarium probably fan-shaped, consists of straight, nearly parallel branches connected by dissepiments at regular intervals. Branches bifurcated at long intervals. Width of branch as wide as that of fenestrule, ranging from 0.256 to 0.282 mm ; 18 branches per 10 mm horizontally. Fenestrules quadrate with rounded corners ; width ranges from 0.231 to 0.321 mm, length ranging from 0.385 to 0.449 mm ; about 18 fenestrules per 10 mm of branch length. Dissepiments narrow, about 0.128 mm in width. Zooecial tubes arranged in strongly alternating longitudinal series ; trigonal or rhomboidal in lower to middle levels of branch, curved outward and circular at upper level of branch, 0.090 to 0.103 mm in diameter. Distance between zooecial apertures from center to center ranges from 0.256 to 0.321 mm ; about 18 zooecia per 5 mm longitudinally, consistently spaced in relation to dissepiment, 2 apertures per fenestrule. Nodes unobservable. Stereom thin, covering reverse side of branch, consists of inner semitransparent layer of colonial plexus and outer sclerenchyma of darker coarse fibers with well developed fine spicules.

Meshwork formula.—18/18//18/? (The meshwork formula used for fenestellids refers to the number of branches per 10 mm/number of fenestrules per 10 mm//number of zooecia per 5 mm/number of nodes in 5 mm).

Remarks.—The present form agrees well with *Fenestella horologia*, the neotype of which was revised by Crockford (1944b) in its microscopic measurements, meshwork formula and all essential characters, except for the arrangement of nodes, which was unobsevable. This species has been known from the Permian of Australia, Thailand, and also from Timor Island and Vancouver Island as *Fenestella parviuscula*.

Alternifenestella sp. indet. A

Figures 6-1

Material and Locality.—MGL74506b (Maqam).
Meshwork formula..—18-20/16//16/?.
Descriptive remarks.—This single tangential section of fragmentary zoarium consists of straight, parallel branches connected by dissepiments at regular intervals. Bifurcation of branches unknown. A detailed comparison with previously described species cannot be made at present because the one fragmentary specimen at hand is too poor for specific identification.

Alternifenestella sp. indet. B

Figures 6-2

Material and Locality.—MGL74508b (Maqam).
Meshwork formula.—16/14//14/?.
Descriptive remarks.—A single tangential section of fragmentary zoarium, consists of straight, parallel branches connected by dissepiments at regular intervals. Bifurcation of branches unknown. The one fragmentary specimen is insufficient for a specific discrimination.

Alternifenestella sp. indet. C

Figures 6-7

Material and Locality.—MGL74508c (Maqam).
Meshwork formula.—18/16//16/indistinct.
Descriptive remarks.—A single tangential section of fragmentary zoarium, consists of fan-shaped, fine meshwork with straight branches connected by dissepiments at regular intervals. Branches bifurcated frequently, as wide as that of

Laxifenestella, *Fabifenestella* and *Rugofenestella* (in mm).

Width of			Length of fenestrules	Diameter of zooecia near surface	Distance between zooecia	Outside diameter of nodes	Distance between nodes
branches	fenestrules	dissepiments					
.256-.282	.231-.321	.128	.385-.449	.090-.103	.256-.321	—	—
.231-.295	.205-.321	.154-.205	.321-.385	.080-.103	.256-.321	ca. .030	indistinct
.256-.385	.256-.321	.218-.296	.449-.513	.115-.128	192-.256	?	indistinct
.231-.256	.192-.256	.167-.192	.385-.513	.060-.070	.295-.359	—	indistinct
.321-.416	.189-.231	.321-.384	.385-.513	.120	.231-.256	—	—
.282-.321	.231-.256	.154-.192	.385-.449	.064-.077	.256-.321	.051-.064	.128-.192
.321-.385	.192-.231	.192-.256	.256-.321	.077-.090	.192-.231	.051-.064	.115-.128
.320-.352	.288-.320	.384-.416	544-.704	.103-.115	.256-.295	—	indistinct
.385-.449	.321-.385	.321-.385	.769-.833	.077-.090	.282-.308	indistinct	—
.321-.385	ca. .385	.231-.256	.769-.833	.064-.077	.256-.321	—	—
.384-.448	.288-.416	.480-.576	.512-.800	.115-.128	.256-.308	.077 ?	?

fenestrules. The present form seems to be similar to *Fenestella macronodata* Sakagami (1964) originally described from the Permian of the Akiyoshi Limestone, however, specific identification must be postponed until better specimens are accumulated.

Alternifenestella sp. indet. D

Figures 6-3

Material and Locality.—MGL74502 (Maqam).

Meshwork formula.—ca.16/13//13/?.

Descriptive remarks.—A single tangential section. Zoarium consists of straight, parallel branches connected by dissepiments at regular intervals. Branches bifurcate at long intervals and are wider than fenestrule. The present form is close to *Fenestella* cf. *retiformis* which was described from the *Parafusulina kaerimizensis* zone of the Akiyoshi Limestone Group, Japan, in its general appearance. However, specific identification must be postponed until better specimens can be accumulated.

Genus ***Minilya*** Crockford, 1944

Minilya duplaris Crockford, 1944

Figures 6-5

Minilya duplaris Crockford, 1944b, p. 173, 174, pl. 1, figs. 5, 7, text-fig. 1C, D; Crockford, 1946, p. 132; Crockford, 1957, p. 67, 68.

Material and Locality.—MGL74517b (Maqam).

Description.—A single tangential section was examined. Zoarium consists of straight, parallel branches connected by dissepiments at regular intervals. Branches bifurcate at very long intervals. Branches wider than fenestrules, ranging from 0.282 to 0.321 mm; about 20 branches per 10 mm horizontally. Fenestrules hourglass-shaped because zooecial apertures intrude at their sides, width ranging from 0.231 to 0.256mm, length ranging from 0.385 to 0.449 mm; about 18 fenestrules per 10 mm of branch length. Dissepiments narrow, 0.154 to 0.192 mm in width. Zooecial tubes alternately intersecting longitudinal series, triangular to pentagonal at lower level of branch, curved outward, pentagonal at middle and circular at upper levels of branch. Zooecial diameters near surface range from 0.064 to 0.077 mm. Distance between zooecial apertures from center to center ranges from 0.256 to 0.321 mm; about 18 zooecia per 5 mm longitudinally, consistently spaced in relation to dissepiment, 2 apertures per fenestrule, two rows of zigzag nodes prominent on well developed broad carina. Total number of nodes about 36 per 5 mm of branch length. Nodes range from 0.051 to 0.064 mm in outside diameters spaced at same interval as apertures, namely one node to each zooecial aperture. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus and outer sclerenchyma of darker fibers with very small granules.

Meshwork formula.—20/18//18/36.

Remarks.—The present form is nearest to *Minilya duplaris* in the meshwork formula and essential characters. This species was originally described by Crockford (1944b) as the type species of the newly established genus *Minilya* from the Noonkanbah series of Western Australia. Later, Wass (1966) discussed the specimens of *Fenestella horologia* and *Minilya duplaris* Crockford and concluded that those two species are conspecific and therefore, because of priority, *Minilya duplaris* is invalid. However, these two species seem to be different in the number of nodes per 5 mm of branch length as shown in Table 1 of Wass (1966). The genus *Minilya* is now recognized widely and is treated here as a valid genus.

Minilya sp. indet.

Figures 6-6

Material and Locality.—MGL74524a (Maqam).

Meshwork formula.—18/20//20/40.

Descriptive remarks.—A single tangential section of fragmentary zoarium consisting of straight branches connected by dissepiments at regular intervals. Bifurcation of branch not observed. The present form is very near to the above-described species *Minilya duplaris* in the meshwork formula, but it can be distinguished from the latter form by the microscopic measurements, namely the width of branches is narrower than that of the fenestrules in *M. duplaris* but wider in the present form, and by the shapes of the zooecial tubes in the middle level of the branch in tangential section. The specific denomination, however, must be reserved because of the poorly preserved specimen.

Genus ***Laxifenestella*** Morozova, 1974

Laxifenestella lahuseni (Stuckenberg), 1895

Figures 6-4

Fenestella lahuseni Stuckenberg, 1895, p. 148, 149, pl. 21, fig. 14; Nikiforova, 1938, pp. 80, 81, 231, pl. 14, figs. 1-5, text-figs. 41-43.

Fenestella lahuseni, forma A, Shulga-Nesterenko, 1936, p. 260,

Table 3. Measurements of the species

Species	Specimen No. (MGL)	No. per 10 mm		No. of zooecia	
		branches (horizontally)	fenestrules (longitudinally)	per 5 mm	per fenestrule
Polypora cf. *P. elliptica*	74510, 74524b	(13)-15	10	18-20	4
Polypora cf. *P. gigantea*	74516c	7?	2.5-3	12-13	ca. 10
Polypora sp. indet.	74504	10	4.5	14-15	(4?)-5

261, 281, text-figs. 25, 26.

Fenestella lahuseni var. *monoseriata*, Shulga-Nesterenko, 1941, p. 55, 56, pl. 3, fig. 3.

Material and Locality.—MGL74512b (Maqam).

Description.—A single tangential section of fragmentary zoarium, consisting of nearly straight branches connected by dissepiments at regular intervals. Branches may bifurcate frequently because zooecial tubes arranged in 3 rows just before bifurcation are observed often. Width of branch about as wide as or slightly wider than that of fenestrule, ranging from 0.320 to 0.352 mm, about 16 branches per 10 mm horizontally. Fenestrules elongate, quadrate with rounded corners, width ranging from 0.288 to 0.320 mm, length 0.544 to 0.704 mm ; about 10 fenestrules per 10 mm of branch length. Dissepiments rather wide, range from 0.384 to 0.416 mm in width. Zooecial tubes form very limited alternating longitudinal series, elongate quadrate or deformed pentagonal at middle level of branch, and circular at upper level, range from 0.103 to 0.115 mm in diameter. Zooecial apertures about 20 per 5 mm in a range, usually 4 zooecia per fenestsrule. Nodes indistinct. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus and outer sclerenchyma of darker fibers with small granules.

Meshwork formula.—16/10//20/?.

Remarks.—Although the nodes are indistinct, the present form is nearest to *Fenestella lahuseni* var. *monoseriata* in the meshwork formula, and the shape and arrangements of zooecial tubes at the middle level of the tangential section. Shulga-Nesterenko's specimens from the Lower Permian of the middle Pechora region of the Northern Urals, Russia, may be included in *Fenestella lahuseni*. The original specimen of this species was described by Stuckenberg (1895) from the Lower Permian (Artinskian) of the Kolva river region in Russia and was reexamined by Nikiforova (1938).

Genus ***Fabifenestella*** Morozova, 1974

Fabifenestella subpermiana (Shulga-Nesterenko), 1952

Figures 7-1

Fenestella subpermiana Shulga-Nesterenko, 1952, p. 31, pl. 3, fig. 1, text-figs. 10, 11 ; Gorjunova, 1975, p. 71, pl. 13, fig. 1.

Material and Locality.—MGL74521a (Maqam).

Description.—A single tangential section was examined. Zoarium consists of nearly straight branches connected by dissepiments at regular intervals. Branches bifurcated at long intervals. Branch width ranges from 0.385 to 0.449 mm and about 12 branches per 10 mm horizontally. Fenestrules elongate, quadrate with rounded corners, width ranges from 0.321 to 0.385 mm, length ranges from 0.769 to 0.833 mm, about 9 fenestsrules per 10 mm of branch length. Dissepiments moderate, width ranging from 0.321 to 0.385 mm. Zooecial tubes in limited alternating longitudinal series, usually kidney-shaped at middle level of branch, curved outward and circular at upper level, range from 0.077 to 0.090 mm in diameter. Zooecial apertures about 18 per 5 mm in a range, consistently positioned in relation to dissepiment, 4 zooecia per fenestrule. Nodes indistinct. Stereom covering reverse side of branch consists of inner semitransparent layer with three to four fine striations of colonial plexus and outer sclerenchyma of coarser fibers with very small granules.

Meshkwork formula.—12/9//18/indistinct.

Remarks.—The present form is similar to *Rugofenestella basleoensis*, described in the present report, in microscopic measurements, but it differs from the latter by the shape of the zooecial tubes in tangential section and the internal structure of the reverse side of the branch. The present form agrees with *Fenestella subpermiana*, especially as described by Gorjunova (1975) from the upper part of the '*Schwagerina*' horizon of the Lower Permian of the Bashkirian ASSR, Pamir in microscopic measurements.

Genus ***Rugofenestella*** Termier and Termier, 1971

Rugofenestella basleoensis (Bassler), 1929

Figures 7-2

Fenestella basleoensis Bassler, 1929, p. 74, pl. 240(16), figs. 5-9 ; Fritz, 1932, p. 99 ; Shulga-Nesterenko, 1936, p. 253-254, 277, text-fig. 16 ; Shulga-Nesterenko, 1939, p. 70, pl. 12, fig. 3 ; Shulga-Nesterenko, 1941, p. 102, pl. 19, fig. 4 ; pl. 20, figs. 1-3 ; Crockford, 1957, p. 58 ; Sakagami, 1968b, p. 73, text-fig. 3G ; Xia, 1986, p. 218, pl. 6, figs. 13, 14 ; Xia, 1991, p. 173, pl. 1, fig. 3.

Material and Locality.—MGL74521b (Maqam).

Description.—A single tangential section was examined. Zoarium consists of straight branches connected by dissepiments at regular intervals. Branches bifurcate at long intervals. Branch width ranges from 0.321 to 0.385 mm with about 13 branches per 10mm horizontally. Fenestrules elongate, quadrate with rounded corners, width about 0.385 mm, length ranging from 0.769 to 0.833 mm, about 9 fenestrules per 10 mm of branch length. Dissepiments moderate, width ranging from 0.231 to 0.256 mm. Zooecial tubes

of *Polypora* (in mm).

No. of rows of zooecia	Width of			Length of fenestrules	Diameter of zooecia near surface	Distance between zooecia
	branches	fenestrules	dissepiment			
(2)-3	.416-.480	.256-.320	.320-.480	.480-.704	.115-.128	.256-.321
(5)-6-(8)	.960-1.216	ca. .500	ca. .640	ca. .300	ca. 115	.385-.410
4	ca. .640	ca. .480	.640-.704	1.120-1.280	.115-.128	.385-.449

arranged in strongly alternating longitudinal series, usually triangular at middle level, curved outward and circular at upper level of branch. Openings of zooecial tubes near surface rather small, ranging from 0.064 to 0.077 mm in diameter. Zooecial apertures about 18 per 5 mm in a range, consistently positioned in relation to dissepiment, usually 4 zooecia per fenestrule. Nodes indistinct. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus and outer sclerenchyma of coarser fibers with small granules.

Meshwork formula.—13/9//18/indistinct.

Remarks..—As the original specimen of *Fenestella basleoensis* from Timor Island was described on the basis of only a surface specimen by Bassler (1929), the internal structures are not distinct. However, the present form is identical with the Timor specimens in the meshwork formula and measurements. This species is widely distributed in the Tethyan region, being found in Timor, Thailand, China and the Ural region of Russia.

The present form is almost identical with *Fabifenestella subpermiana* (MGL74521a) described in the present report in measurements, but it can be distinguished distinctly from the latter form by the arrangement of zooecial tubes in the middle level of the branch in tangential section, namely, the strongly alternating intercalated zooecial tubes in the present form instead of the usually kidney-shaped zooecial tubes in the latter form.

Rugofenestella omanica sp. nov.

Figures 7-4, 5

Material and Locality.—MGL74514a (holotype), 74517c (paratype) (Maqam).

Description.—Zoarium consists of nearly straight, parallel branches connected by dissepiments at regular intervals. Branches bifurcate at long intervals. Branch width ranges from 0.384 to 0.448 mm with 13 to 15 branches per 10 mm horizontally. Fenestrules oval or quadrate with rounded corners; width ranges from 0.288 to 0.416 mm, length ranges from 0.512 to 0.800 mm; 8 to 9 fenestrules per 10 mm of branch length. Dissepiments range from 0.480 to 0.576 mm in width. Zooecial tubes arranged in strongly alternating longitudinal series, usually trigonal at middle level of branch, curved outward and circular at upper level of branch, 0.115 to 0.128mm in diameter. Distance between zooecial apertures from center to center ranges from 0.256 to 0.321 mm; 16 to 18 zooecia per 5 mm longitudinally, probably consistent in position in relation to dissepiment, usually 4 apertures per fenestrule. Nodes well developed, arranged in one row on straight carina, ranging from 0.077 to 0.103 mm in outside diameter; spaced at about the same intervals as apertures, namely 16 to 18 nodes per 5 mm of branch length. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus and outer sclerenchyma of darker fibers with very fine granules and some well developed spicules.

Meshwork formula.—13-15/8-9//16-18/16-18.

Remarks.—The present form seems to be nearest to the preceding species *Rugofenestella basleoensis*, especially the specimen described by Shulga-Nesterenko (1941) from the Lower Permian of the Ural region, Russia, in the meshwork formula except for the number of nodes in 5 mm branch length. The present form can be distinguished from the type *basleoensis* by Bassler (1929) from Timor by the wider dissepiments and smaller number of nodes in 5 mm branch length.

Genus ***Penniretepora*** d'Orbigny, 1849

Penniretepora sp. indet.

Figures 8-3

Material and Locality.—MGL74506a (Maqam).

Descriptive remarks.—A single tangential section of zoarium consisting of a pinnate, broad, straight main branch and short lateral branches. Width of main branch ranging from 0.650 to 0.700 mm. Lateral branch about 0.320 mm in width, extending alternately at about 70 degrees to main branch and at intervals of about 1.00 mm with about 3 lateral branches per 5 mm length of main branch. Zooecial tubes arranged in alternately longitudinal series, triangular with rounded corners at middle level of branch, oval in tangential section near surface, 10 to 11 zooecia per 5 mm length of one range and spaced regularly in pairs per interval between lateral branches.

The present form resembles *Pennirepora granulosa* which was described by Crockford (1944a) from the Callytharra series (Permian) of Western Australia in the measurements of the zoarium, however, a detailed comparison of them cannot be made at present, because Crockford (1944a) described and illustrated the type specimens by surface observation.

Family Septoporidae Morozova, 1962
Genus ***Septopora*** Prout, 1859

Septopora sp. indet.

Figures 8-2

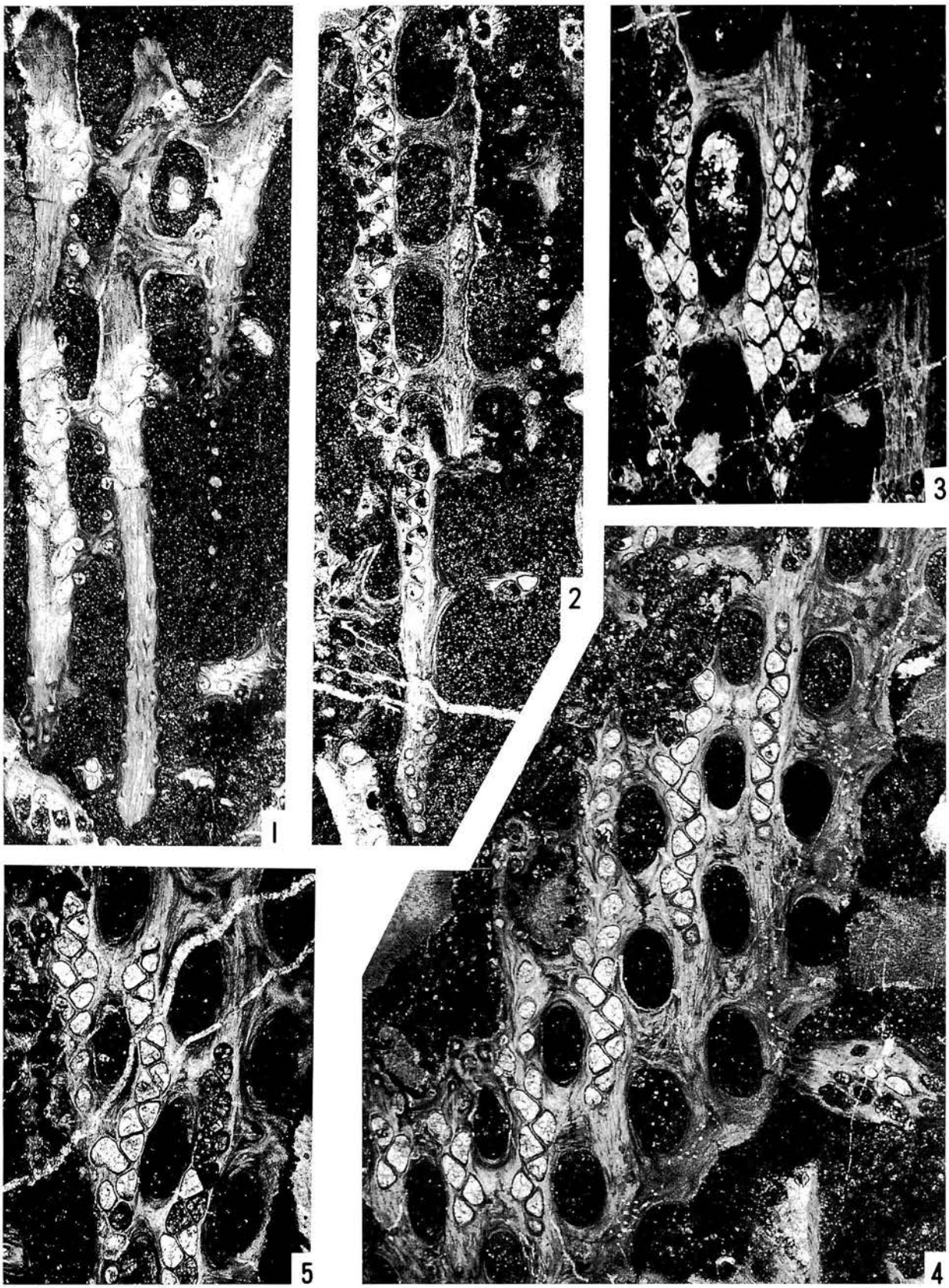
Material and Locality.—MGL74520c (Maqam).

Meshwork formula.—10/7//18/?

Descriptive remarks.—Form of zoarium unknown but probably fan-shaped based on the single fragment examined. Zoarium consists of straight, parallel branches connected by dissepiments at regular intervals.

The present form is identical with *Septopora ivanovi*

Figure 7. **1.** *Fabifenestella subpermiana* (Shulga-Nesterenko), tangential section, MGL74521a. **2.** *Rugofenestella basleoensis* (Bassler), tangential section, MGL74521b. **3.** *Polypora* sp. indet., tangential section, MGL74504. **4, 5.** *Rugofenestella omanica*, n. sp., tangential sections, MGL74514a (holotype) and 74517c (paratype). (All figures are ×20)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described by Shishova (1952), but Shishova's species was from the Mjachkovsky to Kasimovsky horizons (Middle to Upper Carboniferous) of the Moscow region, Russia, in the meshwork formula. The present form seems to be nearest to *Septopora regulata* by Yang and Lu (1962) from the Bayinhe Formation (Lower Permian) of Qilianshan, China in essential characters but the meshwork measurements are different, the meshwork formula of the Chinese specimens being 10.5/11//12.5/20. Specific identification is not possible because only one poorly preserved specimen is at hand.

Family Polyporidae Vine, 1883
Genus ***Polypora*** McCoy, 1844

Polypora cf. ***P. elliptica*** Rogers, 1900

Figures 6-8; 8-1

Compared.—
Polypora elliptica Rogers, 1900, p. 7, 8, pl. 4, fig. 2, Moore, 1929, pp. 23, 24, pl. 3, figs. 7, 8, 20; Sakagami, 1995, p. 270, figs. 4-4; 5-1.
Polypora elliptica (s.s) Rogers. Elias, 1937, p. 327, 328, fig. 3 m.

Material and Locality.—MGL74510, 74524b (Maqam).

Description.—Two tangential sections were examined. Zoarium consists of straight, parallel branches connected by dissepiments at regular intervals. Branches bifurcate infrequently. Branch width wider than width of fenestrule, ranging from 0.416 to 0.480 mm, usually about 15 branches per 10 mm horizontally. Fenestrules elongate, oval in outline; width ranges from 0.385 to 0.480 mm, length from 0.385 to 0.704 mm, usually about 10 per 10 mm of branch length. Dissepiment broad, ranges from 0.320 to 0.480 mm in width. Zooecial tubes usually 3 rows but before bifurcation of branch 4 rows, after bifurcation 2 rows; elongate quadrate or elongate hexagonal at middle level of branch because of slightly alternating intercalated zooecial tubes in longitudinal series. Zooecial tubes circular in tangential section near surface, ranging from 0.115 to 0.128 mm in diameter. Number of zooecial apertures ranges from 18 to 20 per 5 mm length of one range, usually 3 to 4 apertures per fenestrule. Distance between zooecial apertures ranges from 0.250 to 0.321 mm longitudinally. Stereom covering reverse side of branch consists of semitransparent layer of colonial plexus with some capillary canals and outer sclerenchyma of darker fibers with well developed fine granules.

Meshwork formula.—13-15/10//18-20/3(2) (The meshwork formula used for *Polypora* and *Protoretepora* refers to the number of branches per 10 mm/number of fenestrules per 10 mm//number of zooecia per 5 mm/number of rows of zooecia).

Remarks.—The present form resembles *Polypora elliptica*, originally described by Rogers (1900) from the Kereford Limestone of the Oread Formation, dated now as middle Virgilian in the meshwork formula and internal structures. This species was described by Sakagami (1995) also from the lower to middle part of the *Eoparafusulina* zone of the Copacabana Group in Bolivia.

Polypora cf. ***P. gigantea*** Waagen and Pichl, 1885

Figures 8-4

Compared.—
Polypora gigantea Waagen and Pichl, 1885, p. 786-789, pl. 89, figs. 1, 2; Sakagami, 1963, p. 208, 209, pl. XII, figs. 15, 16.

Material and Locality.—MGL74516c (Maqam).

Description.—A single tangential section of fragmentary zoarium consisting of straight, parallel, robust branches connected by dissepiments with long intervals. Branch width ranges from 0.960 to 1.216 mm; probably about 7 branches per 10 mm horizontally. Fenestrules very elongate, about 0.500 mm in width and about 3.00 mm in length; 2.5 to 3 per 10 mm length of branch. Width of dissepiments is about 0.640 mm. Zooecial tubes arranged in strongly alternating longitudinal series, usually rhomboidal at middle level of branch, 6 rows of each branch, before bifurcation 8 rows, after bifurcation 5 rows; 12 to 13 per 5 mm length of one range, probably about 10 zooecial apertures per fenestrule. Zooecia circular in tangential section near surface, about 0.115 mm across. Distance between zooecial apertures from center to center ranges from 0.385 to 0.410 mm, longitudinally. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus with many capillary canals and outer sclerenchyma of dark coarse fibers with fine granules.

Meshwork formula.—7?/2.5-3//12-13/(5)-6-(8).

Remarks.—The present form may be identical with *Polypora gigantea* which Waagen and Pichl (1885) described from the Middle *Productus* Limestone of Pakistan, however, detailed comparisons cannot be made based on the one poorly preserved specimen at hand.

Polypora sp. indet.

Figures 7-3

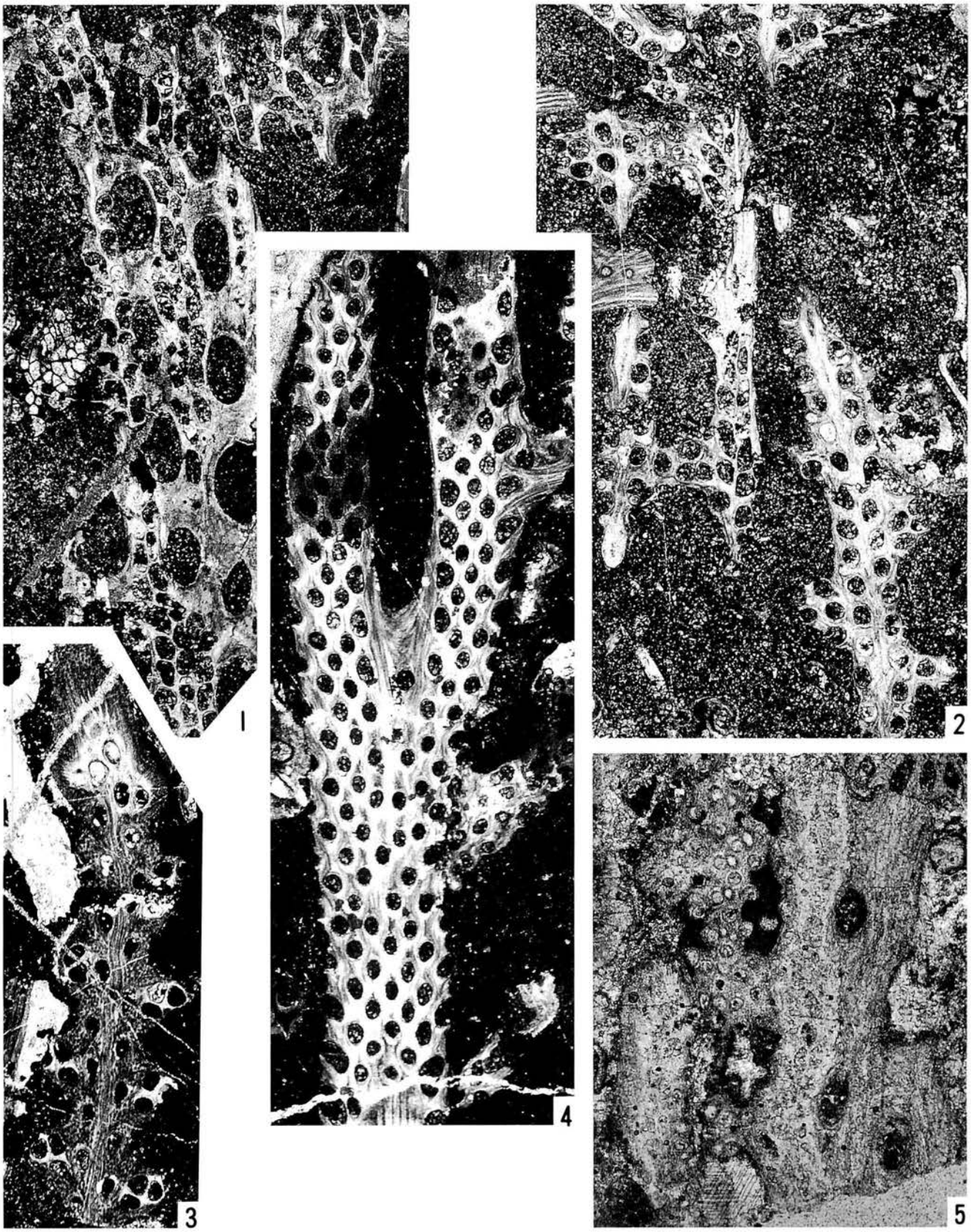
Material and Locality.—MGL74504 (Maqam).

Meshwork formula.—10/4.5//14-15/4.

Descriptive remarks.—A single tangential section of fragmentary zoarium consisting of straight, parallel branches connected by dissepiments at regular intervals. Bifurcation of branches not observed in this specimen. Only one poorly preserved specimen is available and this is insufficient for specific identification.

Genus ***Protoretepora*** de Koninck, 1876

Figure 8. **1.** *Polypora* cf. *P. elliptica* Rogers, tangential section, MGL74524b. **2.** *Septopora* sp. indet. tangential section, MGL74520c. **3.** *Pennironetepora* sp. indet., tangential section, MGL74506a. **4.** *Polypora* cf. *P. gigantea* Waagen and Pichl, tangential section, MGL74516c. **5.** *Protoretepora*? sp. indet., tangential section, MGL74531c. (All figures are ×20)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Protoretepora ? sp. indet.

Figures 8-5

Material and Locality.—MGL74531c (Nackl).

Meshwork formula.—ca. 12/ca. 8//ca. 18/4-5.

Descriptive remarks.—A single tangential section of fragmentary zoarium consisting of straight, parallel branches connected by broad dissepiments with zooecial tubes at regular intervals. Bifurcation of branches not observed in this specimen. The present form seems to belong to the genus *Protoretepora* in having zooecial apertures in the dissepiments, however, only one poorly preserved specimen is available and this is insufficient for a specific identification.

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