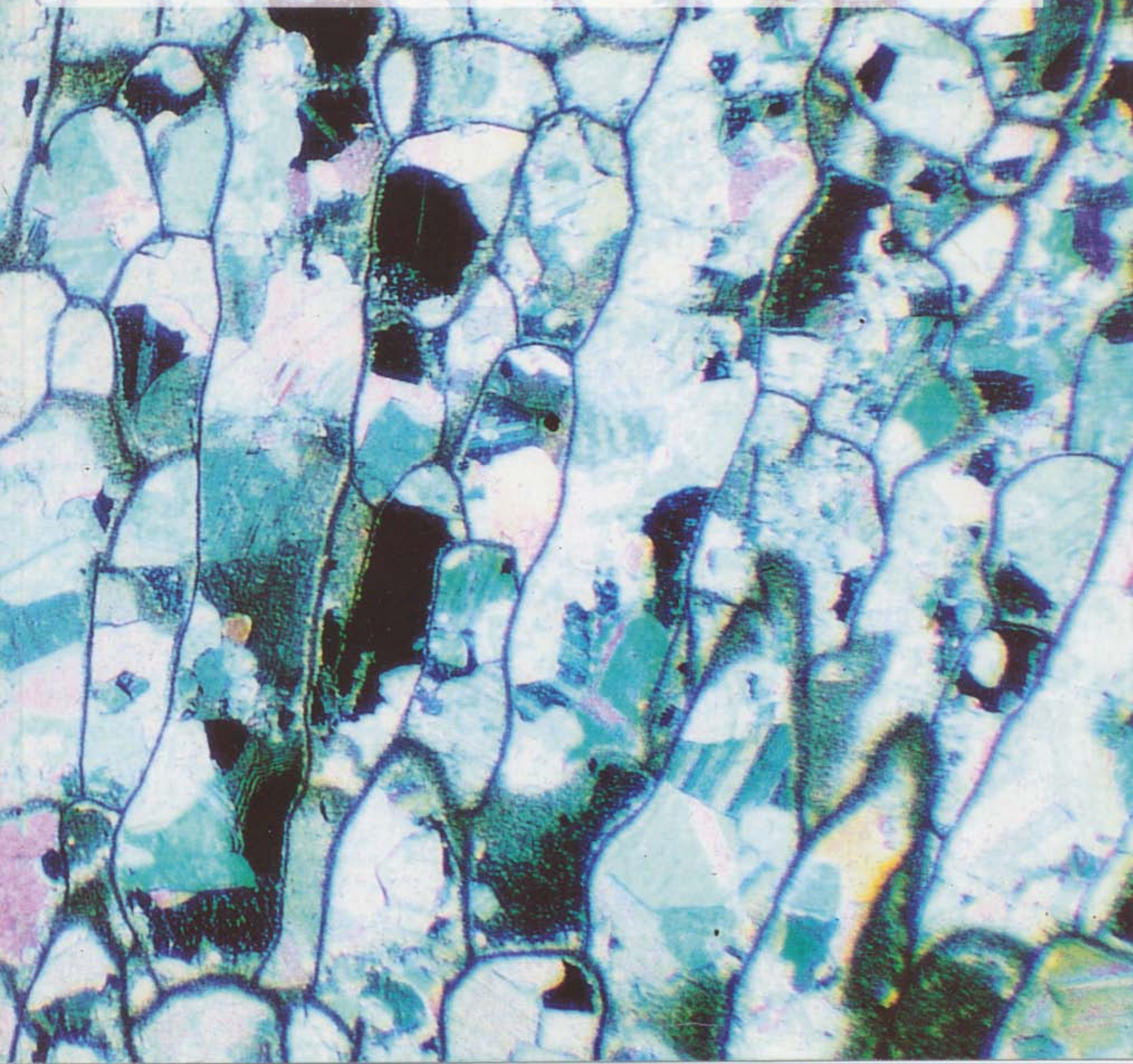
HANS ARNE NAKREM

BRYOZOANS FROM THE LOWER PERMIAN VØRINGEN MEMBER (KAPP STAROSTIN FORMATION), SPITSBERGEN, SVALBARD

NORSK·POLARINSTITUTT

SKRIFTER NR. 196
OSLO 1994



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Cover: Thin section of the cystoporate bryozoan *Cyclotrypa eximia* Morozova, from the Vøringen Member at Festningen (PMO A42218)

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ISBN 82-7666-080-0
Printed December 1994
Printed in Great Britain by Page Bros, Norwich

PUBLISHER
Norsk Polarinstitutt (Norwegian Polar Institute), Middelthuns gate 29, Postboks 5072 Majorstua, N-0301 Oslo, Norway.

SUBSCRIPTIONS
Skrifter is issued irregularly and priced at the time of publication. Orders may be placed through your bookstore or direct from Norsk Polarinstitutt.

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Nakrem, H. A. 1994: Bryozoans from the Lower Permian Vøringen Member (Kapp Starostin Formation), Spitsbergen, Svalbard. *Norsk Polarinstitutt Skrifter 196*.

Bryozoans of the orders Cystoporata, Trepostomata, Cryptostomata and Fenestrata are represented by 41 species (four of which are new: *Meekopora magnusi*, *Fenestella akselensis*, *Fenestella reversicnotta*, *Lyropora serissima*) in the Vøringen Member (Kapp Starostin Formation). The bryozoans have strong affinities with faunas previously described from the Sverdrup, Wandel Sea and Timan–Pechora basins, and may generally be correlated with Artinskian–Kungurian faunas from these basins. Growth forms reflect the depositional conditions with low, robust fenestrates and thick ramose and encrusting trepostomes and cystoporates in the shelly coquinas in the lowermost part, and more delicate fenestrates, trepostomes and cryptostomes in the shaley limestones near the top of the unit.

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Introduction

The Svalbard archipelago, including Spitsbergen, the largest island of the group, is located on the northwestern part of the Barents Shelf (Fig. 1). The well-studied Permian succession here totals some 900+ m, apparently with few depositional breaks. Bryozoans are present in varying abundance through this succession, and the present study concentrates on one rather rich interval of latest Early Permian age. The Vøringen Member of the Kapp Starostin Formation (Tempelfjorden Group) has long been known to contain rich bryozoan faunas. Recently Sakagami (1992) illustrated and identified, but did not describe, forty-one species from the Kapp Starostin Formation at Festningen, Spitsbergen. The primary purpose of this study is to describe the taxonomic composition, the stratigraphical distribution and the palaeoecology of the bryozoan fauna from the Vøringen Member.

Geological setting

The Vøringen Member (Spirifer Limestone in older literature; Nathorst 1910) is the lowermost unit in the Kapp Starostin Formation, which is part of the Tempelfjorden Group (Cutbill & Challinor 1965) (Fig. 2). The Kapp Starostin Formation was previously named the Brachiopod Cherts by Gee et al. (1953) and Starostinskaya Svita in Russian literature (e.g. Morozova & Kruchinina 1986). This massive grey limestone unit has a maximum thickness of about 30 m in the inner Isfjorden area (e.g. Sveltihel), whereas it is 22 m thick in its type section at Kapp Starostin (Festningen profile) and about 14 m at Akseløya.

As the major part of the bryozoan material was collected at Akseløya, the following description refers to this section. The description is based on personal field observations and Fredriksen (1988). The boundary between the Vøringen Member and the Gipshuken Formation is sharp and easily seen in the field (Fig. 3). The basal beds of the Vøringen Member contain carbonate lithoclasts from the Gipshuken Formation, quartz pebbles, as well as quartz sand mixed with fossil debris. The member is dominated by medium to thickly bedded shell coquinas with alternating grainstone and packstone matrix. The fauna is characterized by abundant brachiopods and bryozoans, fragmented crinoids and sponge spicules.

The upper boundary of the Vøringen Member grades into shales with *Zoophycos* trace fossils, and is believed to reflect slightly deeper and more quiet conditions of deposition. Based on both sedimentological and palaeontologcal evidence, the Vøringen Member is interpreted as representing a marine shoreface facies deposited outside a barrier complex under transgressive conditions. The underlying strata of the Gipshuken Formation represent a backbarrier facies, and the overlying shales and cherts represent an open marine platform. During the formation of the Vøringen Member, Spitsbergen drifted northwards from about 35°N to 40°N palaeolatitude, resulting in a depositional shift from warm arid to cooler humid climatic conditions (Steel & Worsley 1984; Worsley et al. 1986).

Fauna and biostratigraphy

The rich brachiopod fauna has a distinct Early Permian affinity compared with similar faunas

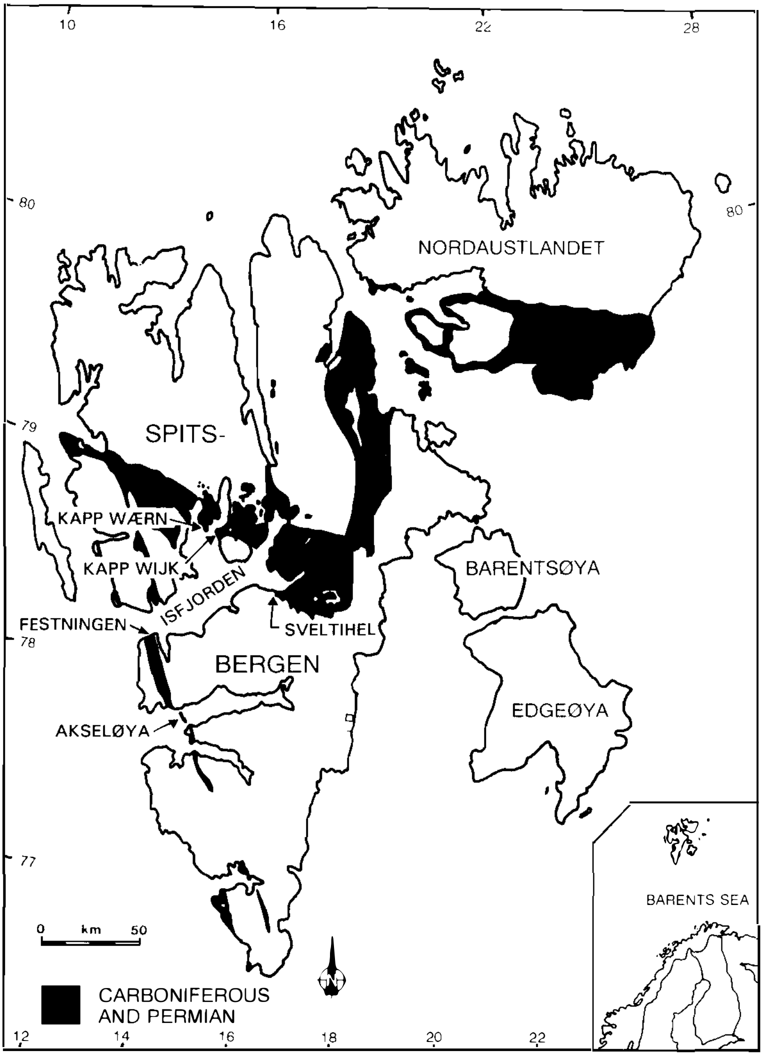

Fig 1. The Svalbard archipelago, showing Late Carboniferous–Permian rocks in black (based on Winsnes 1988) and sampled localities. Inset map shows position of Svalbard in the Barents Sea. In the materials descriptions, the sections in Spitsbergen are coded as AKS–A (= Akseløya), FES–10 (=Festningen), KWI-5 (=Kapp Wijk), KWÆ-1 (Kapp Wærn), SVH–basis (Sveltihel) and SVH–2 (Sveltihel). Added numerical digit to these codes refers to metres above base of the Vøringen Member.

from the Canadian Arctic and eastern North Greenland (Gobbett 1963; Nakamura et al. 1987). Typical Early Permian species include *Chaoiella neoinflata* (Licharew), *Cleiothyridina royssiana* (Keyserling), *Horridonia timanica* (Stuckenberg) and *Yakovlevia impressa* (Toula). There are, however, also several species in common with the Late Permian faunas of Novaya Zemlya and central East Greenland e.g. *Spirifer striato–paradoxus* Toula, *Waagenoconcha payeri* Toula and *Cancrinella cancrini* (Verneuil) (Gobbett 1963; Nakamura et al. 1987). The *Horridonia timanica* Zone spanning the Vøringen Member is believed by Nakamura et al. (1987) to indicate a latest Early Permian (Kungurian) or earliest Late Permian (Ufimian) age.

Conodonts are fairly common in the Vøringen Member. Szaniawski & Małkowski (1979) described *Neostreptognathodus svalbardensis* from this unit, but some of their figured specimens of *Neostreptognathodus* are placed in synonomy with *N. pequopensis* Behnken, *N. clarki* Kozur and *N. ?ruzhencevi* Kozur; see Orchard & Forster (1988) and Nakrem (1991a). Specimens figured as *Sweetognathus* sp. (Szaniawski & Małkowski 1979: pl. 5, figs. 1–2) are probably *S. whitei* (Rhodes). Taking these re–assignments into consideration, this conodont fauna is correlative to conodont zones P7–P9 of the Sverdrup Basin (Beauchamp et al. 1989), and zones 9–11 of the Urals (Movshovich et al. 1979), indicating a Baigendzhinian (Late Artinskian) to earliest Kungurian age.

Other microfossils are less well known, but small foraminifera of Kungurian age, and pollen and spores of Early to Late Permian age are recorded (see Nakrem et al. 1992). Neither fusulinids nor ammonoids have been reported from this interval.

In addition to the biostratigraphical significance of the bryozoan faunas described in the present work, a preliminary biostratigraphy of the bryozoans in the Permian of Svalbard was presented in Nakrem (1991b). The bryozoans in the Vøringen Member have an Early Permian affinity, with most species in common with the Early Permian of eastern North Greenland, the Kungurian of the Timan–Pechora region and the Artinskian Reefs of the Urals (Morozova & Kruchinina 1986).

Bryozoans

Material and methods

The investigated material was collected by the author during three expeditions to Svalbard (1985, 1986, 1988). The bryozoan study was part of the IKU project "Arctic Geo–Program" (see acknowledgements), and along with the bryozoan sampling, fusulinid, palynological, conodont and other material were also collected.

Bryozoans in the massive limestones of the Vøringen Member are almost exclusively embedded in matrix, and usually observed in section in the field. Very few zoaria can be freed from surrounding matrix for external investigations. This caused problems when trying to obtain the desired oriented sections (tangential, transverse and longitudinal sections). The internal pres-

		STAGE	GROUP	FORMATION	MEMBER
PERMIAN	UPPER	TATARIAN	?–	?–	?–
		KAZANIAN-UFIMIAN	TEMPEL-FJORDEN	KAPP STAROSTIN	HOVTINDEN-SVENSKEGGA
	LOWER	KUNGURIAN			VØRINGEN
		ARTINSKIAN	GIPS-DALEN	GIPSHUKEN	

Fig. 2. Lithological units relevant to this study and their corresponding ages.

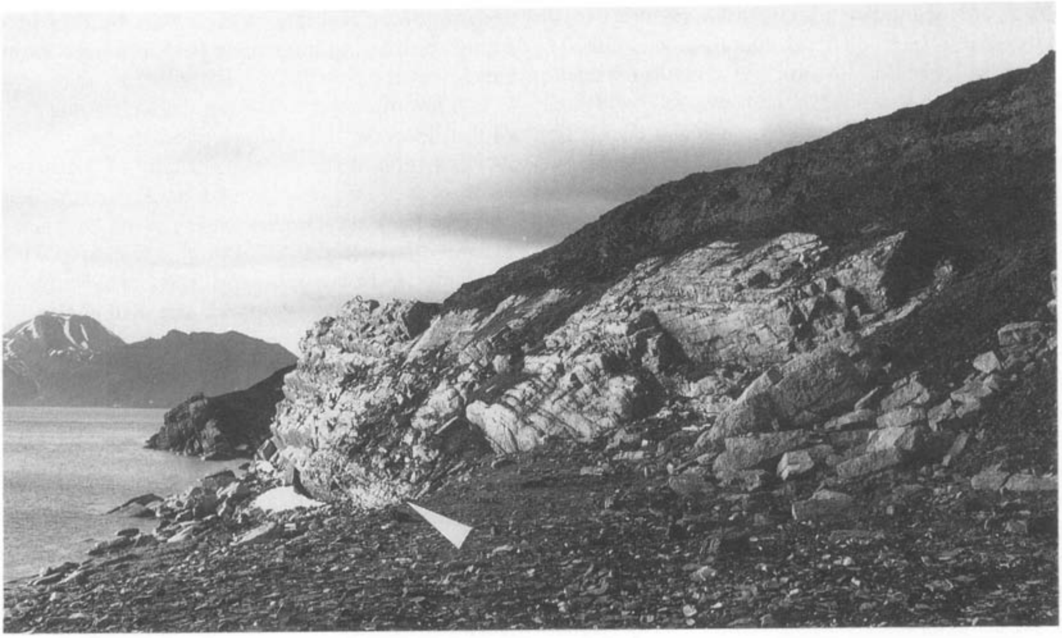

Fig. 3. The light–coloured limestone of the Vøringen Member exposed at the western side of Akseløya (photographed north). The white arrow points to the boundary with the underlying Gipshuken Formation.

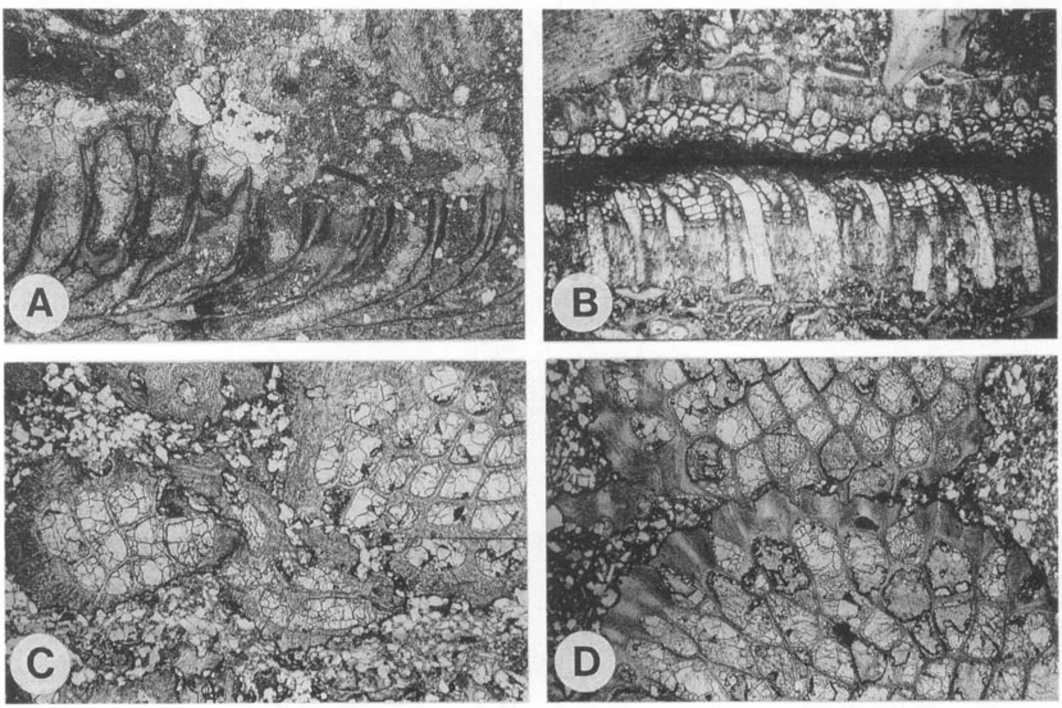

Fig. 4. Preservation of bryozoans. A. Well–preserved trepostome (*Dyscritella*) with acanthostyles projecting into surrounding sediment matrix (AKS–A–1.3m, PMO A42259/2, x25). B. Collapsed colony of *Cyclotrypa* (AKS–A–8.0m, PMO A42654, x10). C. Pressure solution and stylolits between fragments of *Polypora* (AKS–A–11.8m, PMO 118.106/3, x25). D. Pressure solution truncating exozone in *Rhombotrypella* (AKS–A–11.8m, PMO 118.106/1, x25).

ervation is usually good, although local silicification is quite common, and some species could not be described properly due to shortage of well-preserved colonies. Dolomitization is rather rare. Breakage of fragile zoaria is often observed, but most fragments are fairly large. Few zoaria are abraded or show other evidence of extensive transportation, and usually they are well preserved with spines and stylets protruding into the surrounding matrix (Fig. 4A). Pressure solution and stylolite formation is common in the uppermost shaley part of the investigated unit (Fig. 4C, 4D). Some ramose colonies have been preserved with a collapsed endozone, probably due to synsedimentary compaction (Fig. 4B).

The Vøringen Member was sampled at Akseløya (16 horizons) and at Festningen (=Kapp Starostin Point) (11 horizons). Additional samples were collected at Kapp Wijk (1 horizon), Kapp Wærn (5 horizons) and Sveltihel (2 horizons).

Bryozoans were identified from approximately 500 acetate peels and petrographic thin sections. Slabs with bryozoans were sawed from the samples and ground with 220–1000 carborundum paper on a Knuth Rotor polishing device. Polished surfaces were subsequently etched for about 10 seconds in 5% hydrochloric acid and rinsed in water and dried. The etched surfaces were then flooded with acetone and carefully covered with acetate film to prevent air bubbles from developing. Resulting acetate peels were then mounted and stored in standard photographic slide frames. Measurements of morphological characteristics were made directly using a petrographic microscope. All illustrated specimens are in the collections of the Paleontologisk Museum, Oslo (abbreviated PMO).

Previous work on Permian bryozoans from Spitsbergen

Bryozoans have been mentioned in several papers dealing with the Permian of Spitsbergen, but few contain systematic descriptions. Most bryozoans described by Toula (1875) are considered to have been collected from the upper part of the Kapp Starostin Formation at Akseløya. Identifications were based on external measurements and external morphological features. Lee (1908) described several bryozoans, including *Stenopora cidariformis* Lee from the "Bryozoa Limestone" (= Vøringen Member) of Prins Karls Forland. Nikiforova (1936) described new bryozoan species from Kongressdalen, close to Grønfjorden [= Green Harbour], through the upper part of the Kapp Starostin Formation. Bryozoans from Novaya Zemlya were described in the same paper, and the faunas were compared. Although the Novaya Zemlya faunas were badly preserved, resemblances could be noticed. The faunas were also compared with Early Permian faunas known at that time from the Urals. The "Productus Chert Series" of the upper part of the Kapp Starostin Formation was proposed to be of Artinskian age. Forbes et al. (1958) listed bryozoans from several upper Palaeozoic successions from Spitsbergen, including some from the upper part of the Kapp Starostin Formation. Małecki (1968, 1977), revised by Nakrem (1988), described several new bryozoans from the upper part of the Tempelfjorden Group at Bjørnøya (Svalbard) and southern Spitsbergen from horizons time–equivalent to the Kapp Starostin Formation. The most thoroughly illustrated description of bryozoans from the upper part of the Tempelfjorden Group "Starostinskaya Svita") at Spitsbergen and Bjørnøya was published by Morozova & Kruchinina (1986) who identified 23 species. Sakagami (1992) and Sakagami in Nakamura et al. (1990) illustrated bryozoans from the entire Kapp Starostin Formation, the only work to date illustrating bryozoans from the Vøringen Member. Nakrem (1991b) gave a brief biostratigraphical distribution of bryozoans in the Permian of Svalbard, whereas Nakrem (1994) discussed various palaeoecological aspects of these faunas.

Faunal composition

Representatives of all the major Palaeozoic bryozoan orders were found in the present work, although cyclostomes are missing. The composition is typically "boreal", or "northern", with taxa previously reported from Ellesmere Island (Sverdrup Basin), eastern North Greenland (Wandel Sea Basin) and western Siberia (Timan–Pechora Basin) (Ross & Ross 1962; Morozova & Kruchinina 1986; Madsen & Håkansson 1989). At generic level, many of the encountered taxa are also reported from the Tethyan Province as well as from high southern latitudes (Australia) (Ross & Ross 1990). The similarity between the Spitsbergen and other northern faunas supports the proposed open seaway between these basins in Late Palaeozoic times (Stemmerik & Worsley 1989).

The faunas described herein from the Vøringen Member have species in common with faunas described from the Artinskian reefs in the Urals (Trizna 1948, 1950), the Sakmarian–Kungurian of Timan and the Malozemel'sk Tundra (Nikiforova 1938), the Ufimian–Kazanian of Novaya Zemlya (Morozova & Kruchinina 1986), the Early Permian of eastern North Greenland (Ross & Ross 1962) and the Permian of Ellesmere Island (Morozova & Kruchinina 1986). The age, therefore, of the investigated unit is most probably Artinskian–Kungurian, although Late Permian bryozoan species are also common. A precise biostratigraphical zonation based on bryozoan faunas of the Permian has so far not been erected, although they have proven to have local significance (Gilmour & Snyder 1981). Ranges of individual taxa are plotted in Fig. 5 (Akseløya section) and Fig. 6 (Festningen section). The remaining sections contain few sampled horizons, and range charts have not been prepared for these sections.

Palaeoecology

The palaeoecological significance of bryozoan growth forms occurring throughout the Permian of Spitsbergen is outlined in Nakrem (1994). The lower through middle well-washed bioclastic part

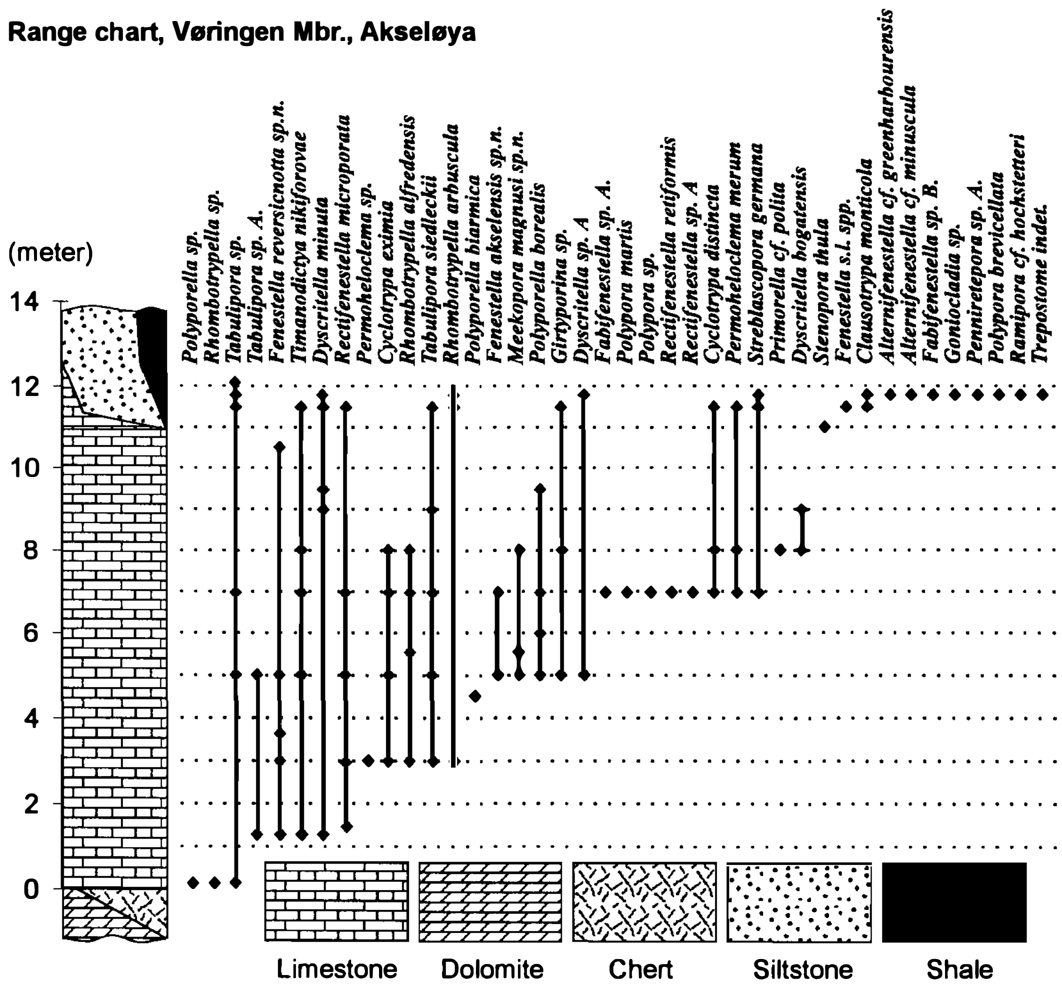

Fig. 5. Lithological column and ranges of species in the Akseløya section of the Vøringen Member. Actual occurrences of each species shown by small black rhombs.

of the Vøringen Member, considered to represent the highest energy depositional phase, is characterized by robust fenestrates (e.g. *Polyporella* and *Lyropora*) with thick and wide branches and dissepiments, and relatively small fenestrule openings. Fenestrate zoaria commonly have a low conical shape; some are observed attached to brachiopod shells (Fig. 7A, C). Encrusters are also common, with thick growth layers of *Cyclotrypa* on brachiopods and other bryozoans (Fig. 7D) and different trepostomes encrusting crinoid stems, brachiopod spines and other bryozoans (e.g. on *Polypora*, Fig. 7B). Trepostomes are commonly stick-like, relatively thick, or encrusting. Generally, these bryozoans are robust and were able to withstand the rather high water energy. Self-overgrowth is observed in several trepostomes. In the upper part of the unit, delicate trepostomes (e.g. *Rhombotrypella* and *Dyscritella*) and cryptostomes (e.g. *Clausotrypa*, *Primorella* and *Permoheloclema*) very often contain fine-grained sediment infilling the outer parts of zooecial tubes. Such specimens are probably washed in from the more quiet waters in the barrier complex, or they may have lived in sheltered pockets. In the uppermost part, coinciding with greater amounts of fine siliciclastic sediments replacing bioclastic skeletal material, fenestrates

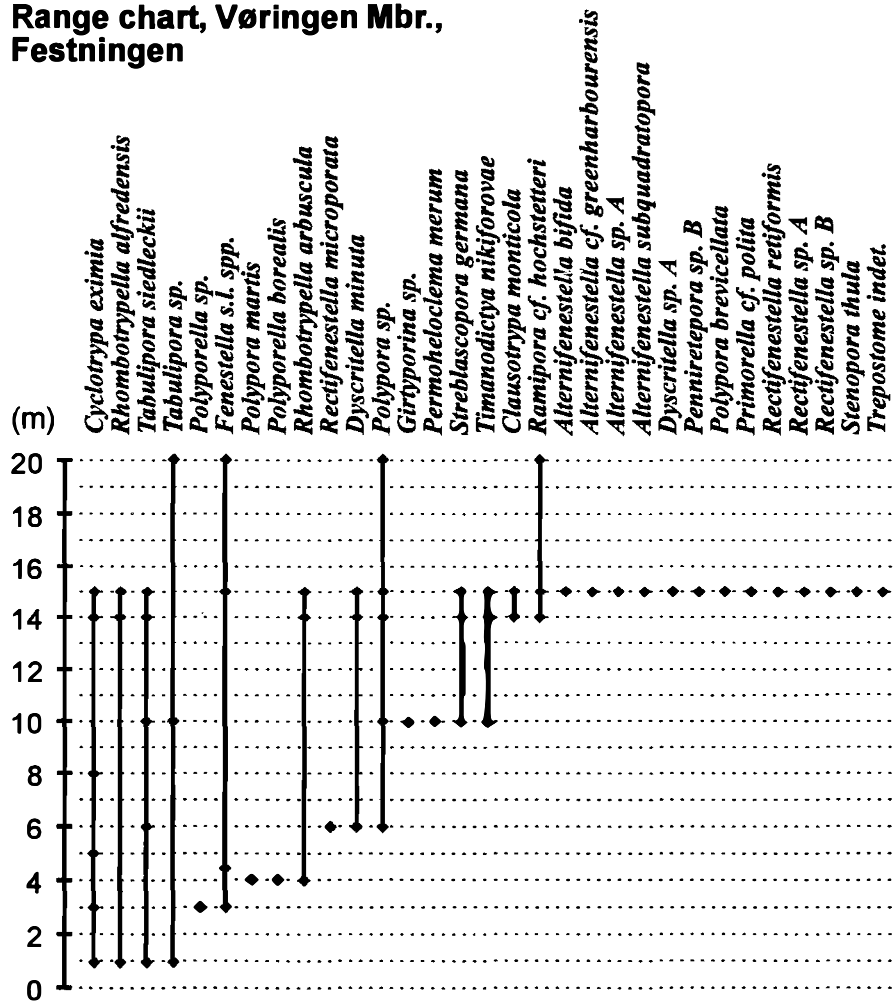

Fig. 6. Ranges of species in the Festningen section of the Vøringen Member. Actual occurrences of each species shown by small black rhombs. Lithological development as in Fig. 5.

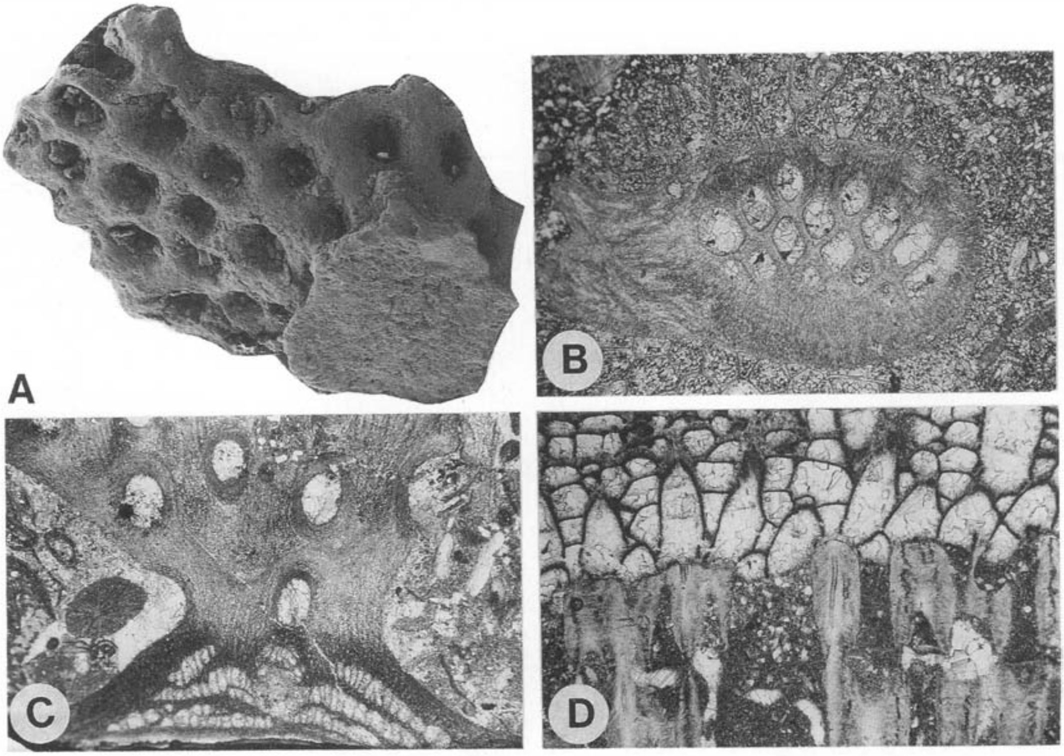

Fig. 7. Some bryozoan growth forms. A. Fenestellid with attachment disc (FES–10–3.5m, PMO 132.105, x15, SEM photo). B. *Polypora* completely overgrown by *Dyscritella* (FES–10–15.0m, PMO 138.084, x25). C. *Polyporella* with basal holdfast attached to a brachiopod shell (AKS–A–9.5m, PMO 118.066, 25x) (brachiopod shell broken free). D. Sheet of *Cyclotrypa* encrusting on *Tabulipora* (FES–10–1.0m, PMO A42218, x25).

are more delicate, and stick–like trepostomes and cryptostomes have smaller colony diameter. A reconstruction of the depositional environments from the high energy shelly coquinas through the deeper (?tens of metres), silty–muddy bottom associations is shown in Fig. 8.

Systematic description of bryozoan taxa

Measurements of zoarial and zooecial characters

Branching ramose colonies of the orders Cystoporata, Trepostomata and Cryptostomata have several zoarial characters in common as observed in tangential, longitudinal and transverse sections (Fig. 9). Different approaches have been taken in utilizing zoarial and zooecial characters, and in the current work the following characters have been found useful in separating different taxa:

- BD Branch diameter in (sub)cylindrical forms
- BT Branch thickness in encrusting or bifoliate colonies
- BW Branch width in bifoliate colonies
- EW Exozone width
- AL Aperture length
- AW Aperture width
- AAR/2 Number of apertures per 2 mm counted along, diagonally and/or across colony surface in tangential section in species with randomly distributed apertures
- AAL/2 Number of apertures per 2 mm along colony surface (replacing AAR/2 in some species)
- AAC/2 Number of apertures per 2 mm diagonally or across colony surface (replacing AAR/2 in some species)

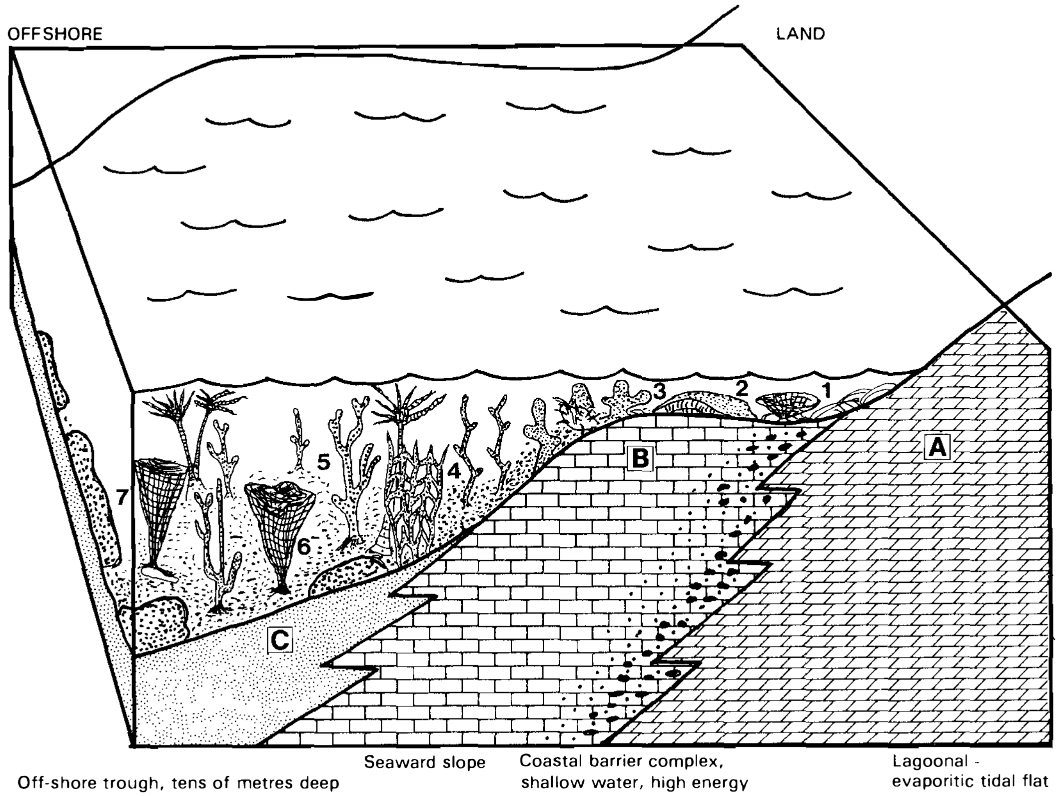

Fig. 8. Reconstructed depositional environments for the Vøringen Member, Kapp Starostin Formation. A. Evaporitic–dolomitic tidal flat deposits in the uppermost part of the Gipshuken Formation. B. Shallow part, as preserved in the lower part of the Vøringen Member. C. Deeper part, as preserved in the upper part of the Vøringen Member. Faunal components: 1, low robust fenestrates; 2, thick sheets of encrusting *Cyclotrypa*; 3, robust ramose trepostomes and cystoporates; 4, delicate *Penniretepora* and fenestrate *Ramipora*; 5, delicate trepostomes and cryptostomes; 6, delicate fenestellids; and 7, sponges. Lithological legend as in Fig. 5.

AAR Distance between nearest–neighbour aperture centres in randomly distributed apertures
AAL Distance between aperture centres along colony (well–oriented apertures)
AAC Distance between aperture centres across colony (well–oriented apertures)
DIA/1 Diaphragms per 1 mm in zooecial tubes
EXWA Exozonal wall thickness
ENWA Endozonal wall thickness

Characters in cystoporates only:
AAS Distance between nearest–neighbour apertures in tangential section
LUNL Length of lunarium
LUNW Width of lunarium
VES/1 Vesicles per 1 mm in transverse or longitudinal section

Characters in trepostomes only:
MACA Diameter of large (macro) acanthostyles
MACA/A Large acanthostyles per autozooecial aperture (tangential section)
MICA Diameter of small (micro) acanthostyles
MICA/A Small acanthostyles per autozooecial aperture (tangential section)
EXIL Diameter of rounded exilazooecia
EXLL Length of ovate or irregular exilazooecia
EXLW Width of ovate or irregular exilazooecia
EXIL/A Exilazooecia per autozooecial aperture (tangential section)
SQ/1 Square zooecial tubes per 1 mm in transverse section (in *Rhombotrypella*)

Characters in cryptostomes only:

AB Diameter of axial bundle of parallel zooecial tubes (in *Streblascopora*)
ACA Acanthostyle diameter (in *Clausotrypa*)
CAP Stylet diameter (in *Timanodictya* and *Permoheloclema*)
FOSS Diameter of fossazooecia (in *Girtyporina*)
LIN Width of zooecial chamber lining (in *Timanodictya* and *Girtyporina*)
MET Metapore dimension (in *Clausotrypa* and *Streblascopora*)
MET/A Metapores per autozooecial aperture (in *Clausotrypa* and *Streblascopora*)

Fenestrate bryozoans are traditionally identified from characters observed in tangential sections, but recent work by Snyder (1991) and Hageman (1991) has shown that both transverse and longitudinal sections are necessary for adequate identification (Fig. 10). Unfortunately, fenestrate zoaria in the present study are usually embedded in rock matrix, often preventing preparation of acetate peels in the three desired orientations. Under other circumstances, freed zoaria should be embedded in epoxy resin for three dimensional sectioning. The following list contains abbreviations of characters relevant for the present study as used by Snyder (1991) and Hageman (1991).

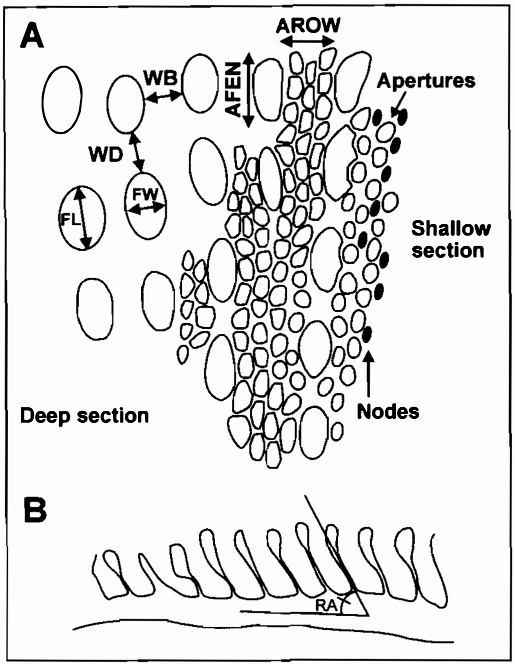

Fig. 10. Sketch of fenestrate bryozoan (*Polyporella*) with measured characters. A. Tangential section. B. Longitudinal section. Abbreviations are explained in the text.

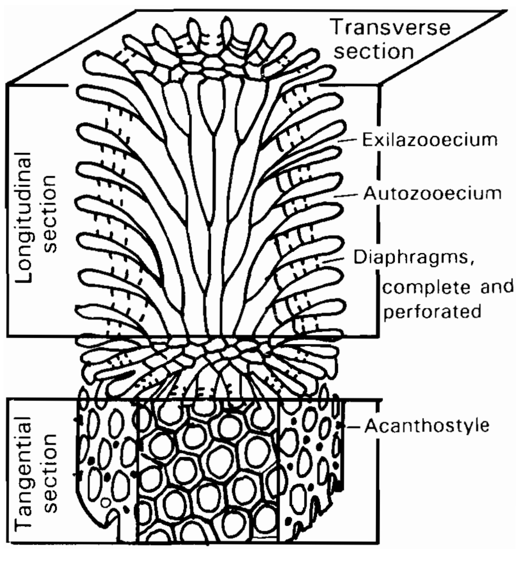

Fig. 9. Sketch of ramose bryozoan showing section orientations. Modified from Boardman & Cheetham (1987, fig. 17.15).

Except those marked with an asterisk (*), these characters are also tabulated in the systematic section in the present work.

LF Length of fenestrule opening

WF Width of fenestrule opening
AAL Distance between aperture centres along branch (=ADB in Hageman 1991)
AAC Distance between aperture centres across branch at closest point (=AAB in Hageman 1991)
AA (*) Aperture length x aperture width (AD, see below)
DN (*) Diameter of nodes on obverse surface (see below, NL and NW)
SNB Distance between nodes along obverse branch surface
WB Width of branch (not measured at branch bifurcation)
TB Thickness of branch (measured on obverse–reverse direction)
WD Width of dissepiment
RA Chamber reverse wall budding angle (measured in longitudinal section)

Some additional characters have been included in the present study:

AD	Aperture diameter
NL	Length of carinal nodes on obverse surface
NW	Width of carinal nodes on obverse surface

To provide data for comparison with older, especially Russian literature, the "micrometric formula" (Miller 1961; Tavener–Smith 1966) was calculated for each species:

BR10	Branches per 10 mm across colony
DS10	Dissepiments or fenestrules per 10 mm along colony
A5	Apertures per 5 mm along branch
AFEN	Number of apertures per fenestrule (family Fenestellidae)
AROW	Number of aperture rows across branch (family Polyporidae)
N1	Carinal nodes per 1 mm along branch

In the systematic description, the micrometric formula is denoted as BR10/DS10/A5/AFEN for fenestellids, and BR10/DS10/A5/AROW for polyporids.

Simple statistics for most characters in each species are presented in Tables 1–34; arithmetic mean (AVG), sample standard deviation (STDS), coefficient of variance (CV= STDS x 100/AVG), minimum– (MIN) and maximum (MAX) values observed, and number of observations (n). "—" indicates that measurements could not be made, usually due to insufficient or badly preserved material. The number of measurements taken for each character vary due to varying availability of well–preserved material. Statistical values were obtained using the PC spreadsheet software Quattro Pro 4.0 from Borland.

Order CYSTOPORATA

Genus CYCLOTRYPA Ulrich, 1896

Type species.—Fistulipora communis Ulrich, 1890, from the Middle Devonian, Iowa.

Remarks.—Cyclotrypa can develop massive, ramose branching and encrusting zoaria with little or no distinction between endo– and exozone. Zooecial tubes are long, zooecial apertures circular or ovate, with weakly developed or no lunaria, the latter feature separating this genus from *Fistulipora.*

Cyclotrypa distincta Morozova, 1986
Plate 1, Figs. A, B, D, E, F

1986 *Cyclotrypa distincta* Morozova in Morozova & Kruchinina, p. 33, pl. 3, figs. 2a–b.

Description.— Ramose branching zoarium with distinct exozone. Branch diameter highly variable, usually 8.0–11.0 mm, maximum diameter 35 mm. Exozone width depending on branch diameter, up to 7.5 mm in the thickest specimens. Apertures are circular or ovate, about 0.26 x 0.24 mm. Apertural width fairly constant, not increasing as aperture length increases. Distance between nearest–neighbour apertures is about 0.14 mm, distance between apertural centres is 0.22–0.46 mm, and there are about 5 apertures per 2 mm in all directions. A collar–like structure, 0.020–0.090 mm wide, is usually lining zooecial apertures. Zooecial tubes are very long with unevenly distributed diaphragms that are most closely spaced in inner exozone, 1.6–6.8 per 1 mm. In transverse section circular cavities observed in stereom are interpreted as bent zooecial tubes arranged parallel to the growth direction and perpendicular to normal tubes opening on colony surface (Pl. 1, Fig. F). Massive microgranular stereom separates zooecial tubes in outer exozone. Vesicular tissue is distributed between zooecial tubes, sometimes in well–defined levels within stereom tissue. In tangential section, zooecial tubes in cross section can be seen separated by vesicular tissue or stereom. The blister–like vesicles are closely packed, about 9 per 1 mm. Maculae are not observed.

Remarks.— Morozova (in Morozova & Kruchinina 1986) described two species of *Cyclotrypa*, both from the Miseryfjellet Formation at Bjørnøya (Svalbard). In addition to their growth habit (encrusting in *C. eximia* and ramose branching in *C. distincta*), Morozova recognized differences in size and spacing of apertures, but the descriptions were based only on the holotypes for each species. Similar differences between the current species of *Cyclotrypa* in the Spitsbergen material is recorded, whereas other characters are fairly similar in the two species (see Tables 1–2).

Comparison.— Permian species of *Cyclotrypa* are known from Kansas, Texas and Oklahoma (Moore & Dudley 1944), but those species are distinguished by the presence of abundant maculae, and commonly larger apertural dimensions. *C. waageni* (Stuckenberg, 1895) and *C. grandis* Nikiforova, 1938 from the Lower Permian of Timan are distinguished in having larger (0.33–0.37 mm) and more widely spaced apertures.

Measurements.—See Table 1.

Material.—AKS–A–7.0m (PMO A42650, 118.075, 118.076), AKS–A–8.0m (PMO A42649, A42654, A42681), AKS–A–11.5m (A42689, A42697). Material refers to measured and/or illustrated specimens; stratigraphic occurrence (range) is shown in Figs. 5 and 6. Sample codes are explaned in Fig. 1.

Stratigraphical distribution outside Spitsbergen.—*C. distincta* was originally described from the Miseryfjellet Formation (Ufimian) in Bjørnøya, Svalbard.

Cyclotrypa eximia Morozova, 1986
Plate 1, Figs. C, G, H; Plate 2, Figs. A–E.

1986 *Cyclotrypa eximia* Morozova *in* Morozova & Kruchinina, pp. 33–34, pl. 3, figs. 1a–d.
1994 *Cyclotrypa* sp., Nakrem, fig. 2c

Description.—Encrusting, sheet–like and multilamellar colonies with maximum observed thickness of 11.0 mm. Encrusted substrates include brachiopods and specimens of *Tabulipora*. There is no clear distinction between endozone and exozone. Apertures are ovate, about 0.32 x 0.27 mm. Distance between nearest–neighbour apertures is about 0.11 mm, distance between apertural centres is 0.24 0.49 mm, and there are about 5 apertures per 2 mm in all directions. Some apertures are closed by stereom tissue (Pl. 2, Fig. D). Thin, straight diaphragms are unevenly spaced, 1.2–5.1 per 1 mm. Some zooecial tubes also contain bubble–like cystiphragms (Pl. 1, Fig. G). Rows of blister–like vesicles are arranged between zooecial tubes, about 7.3 per 1 mm. Vesicles are more densely–packed within stereom with 9–11 per 1 mm. Maculae, 0.9–1.8 X 0.6–0.9 mm, devoid of zooecial apertures, are rarely observed.

Comparison.—*C. eximia* is distinguished from *C. distincta* in growth form (encrusting against ramose branching), and also in zooecial characters; t–tests on zooecial apertural lengths (0.26 *vs.* 0.32 mm) and widths (0.24 *vs.* 0.27 mm) in the two species indicate significant differences ($p<0.001$).

Measurements.—See Table 2.

Material.—AKS–A–3.0m (PMO 118.081), AKS–A–8.0m (PMO 118.065, 132.083, 132.102), FES–10–1.0m (PMO A42096, A42217), FES–10–3.0m (PMO A42284), FES–10–5.0m (PMO 118.090), FES–10–8.0 (PMO 118.091).

Stratigraphical distribution outside Spitsbergen.—*C. eximia* was originally described from the Miseryfjellet Formation (Ufimian) in Bjørnøya, Svalbard.

Genus MEEKOPORA Ulrich, 1889

Type species.—*Meekopora eximia* Ulrich, 1889, from the Lower Carboniferous Chester Series of Illinois.

Remarks.–The bilamellar *Meekopora* is distinguished from *Parameteliopora* which is unilaminar, and from bilamellar *Hexagonella* which has hexagonal ridges on the colony surface.

Meekopora magnusi sp. nov.
Plate 3, Figs. A–E.

Diagnosis.—Thick–branched species of *Meekopora* with regular, flabelliform–shaped, undivided zoarium; smooth surface with large, distinctly elongated monticules; apertures with well–developed lunaria.

Description.—Robust bilamellar–symmetrical colony with a maximum observed thickness of 15.0 mm, thinner at colony margins (7.2 mm). Maximum colony width is 40 mm; maximum length observed is 200 mm. Regularly–spaced monticules devoid of zooecial apertures are developed in rows on colony surface. Monticules are usually 4–7 mm long and 1.3 mm wide. Distance between monticule centres is about 5 mm along, and 3 mm across colony. The outline of the monticules is ovate with stellate lobes. Zooecial apertures with lunaria are distributed in more or less regular rows. Distance between nearest–neighbour apertures is highly variable (0.08–0.31 mm), and distance between apertural centres is 0.32–0.50 mm. There are about 4.5 apertures per 2 mm along colony, and 5.2 per 2 mm diagonally across colony. Total aperture length (including lunarium) is about 0.30 mm, total width is about 0.29 mm. Length of lunarium is 0.06–0.15 mm,

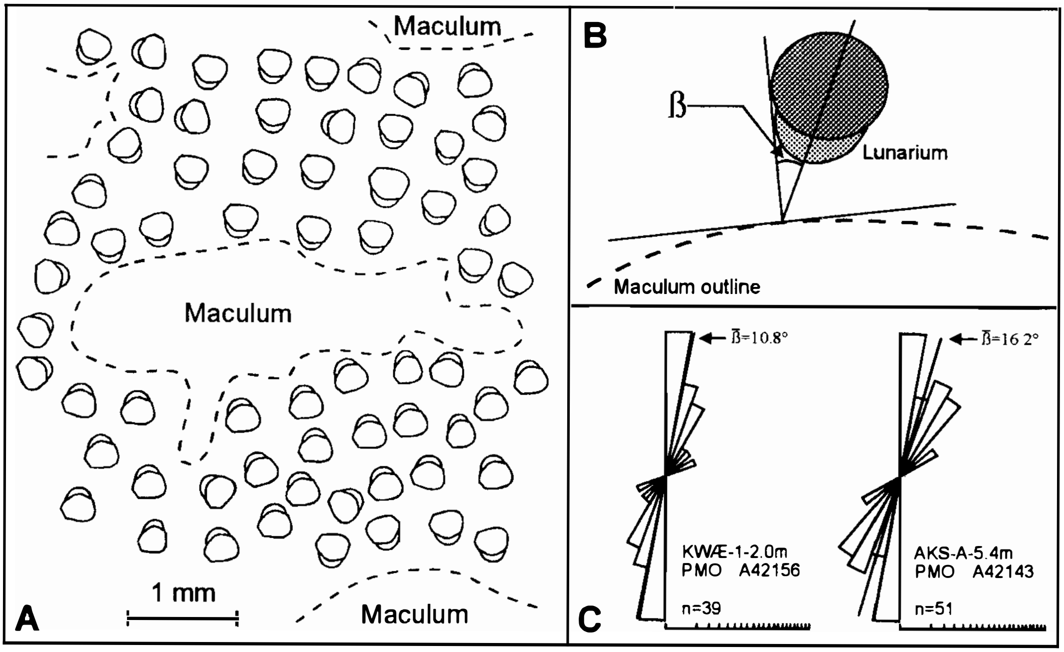

Fig. 11. A. Orientation of lunaria in zooecial apertures bordering a maculum in *Meekopora magnusi*. B. B is the angle deviation from a 90° angle towards a tangential in nearest maculum outline. C. Rose diagrams based on lunarium orientation (B) in two specimens of *Meekopora magnusi* indicating preferred orientations and average deviation.

width is 0.15–0.18 mm. A clear zooecial lining is visible around the apertures. The lunarium is most pronounced in shallowest section producing a key-hole like aperture. Lunaria are directed regularly away from monticules (Pl. 3, Fig. C), and lines drawn through lunaria towards monticules meet long axes of monticules at 90 ·16° (Fig. 11). Zooecia meet colony surface at right angles, and bend slightly near the median lamina. Zooecial tubes contain rare thin diaphragms, in some places 0.90–1.30 mm apart. Bubbly cystiphragms are locally present (Pl. 3, Fig. D). Massive stereom is developed between the zooecial tubes, usually in the exozone. Vesicular tissue formed by blister–like cystozooecia, about 0.036 x 0.054 mm in size, is developed only in certain levels in the exozonal stereom. Where present, there are about 10–14 cystozooecia per 1 mm counted in longitudinal section. Height of cystozooecia diminishes toward zoarial surface. The thickness of the dark median lamina (mesotheca) is 0.09–0.25 mm, with a typical granular–prismatic microstructure.

Comparison.– The thickness (up to 15 mm), combined with the regular flabelliform shape, distinguish the new species from all other known species of *Meekopora.* Relatively thick (seldom as thick as 14 mm) species of *Meekopora* known from the Lower–Middle Permian of Kansas and Arizona (Moore & Dudley 1944) are distinguished by their smaller circular monticules. *M. sellaeformis* (Trautschold, 1876–79) from the Lower Permian of Timan is distinguished in having a maximum colony thickness of 8.2 mm, and smaller (0.20 x 0.15 mm) and more widely spaced apertures.

Types. – Holotype KWÆ–1–2.0m (PMO A42156/1–3), petrographical thin sections. Paratype AKS–A–5.0m (PMO 118.078/1–4), acetate peels and rock specimen.

Type locality.– Kapp Wærn, Spitsbergen, Svalbard.

Type horizon.— Kapp Starostin Formation, 2.0 metres above the base of the Vøringen Member.

Etymology.– From Latin *magnus*, meaning large, great, and for my son, Magnus.

Measurements.– See Table 3.

Material.— AKS–A–5.0m (PMO 118.078), AKS–

A–5.4m (PMO A42143/1–3), AKS–A–8.0m (PMO 118.079), KWÆ–1–2.0m (PMO A42156), SVH–2–25.0m (118.084).

Genus GONIOCLADIA Etheridge, 1876.

Type species. – *Carinella cellulifera* Etheridge, 1873, from the Lower Carboniferous of England.

Goniocladia sp.
Plate 2, Fig. G.

Remarks.– A small fragment of *Goniocladia* was identified from a tangential section in a single sample. Number of branches is 2–2.5 per 10 mm across colony; number of fenestrules 1.5–2 per 10 mm along colony. Diameter of zooecial apertures is probably 0.18 mm, and there are estimated to be 6 apertures per 5 mm along branch surface. Width of branches measures 0.68 to 0.75 mm. Fenestrule openings are hexagonal with a maximum length of 2.73–3.87 mm and a maximum width of 1.82–2.05 mm.

Comparison.– The current fragment of *Goniocladia* provides insufficient information for comparison with other species.

Material.– AKS–A–11.8 (PMO 118.104)

Genus RAMIPORA Toula, 1875

Type species.—Ramipora hochstetteri Toula, 1875 from the Kapp Starostin Formation (Ufimian) of Akseløya, Svalbard.

Ramipora cf. *hochstetteri* Toula, 1875
Plate 2, Figs. F, H.

cf. 1875 Ramipora hochstetteri Toula, p. 230, pl. 10, figs. la–b.

Description.—Fragments of *Ramipora* cf. *hochstetteri* are very common in the examined material, but larger, more complete zoaria have not been detected, as is also true for many other fragile bryozoans in the Vøringen Member. *Ramipora* is composed of a reticulate meshwork with anastomosing branches as in *Septopora* and *Synocladia*, but the branches are bifoliate. Maximum branch width is about 1.80 mm, and maximum height (=colony thickness) is about 1.90–2.10 mm. The fragmented material prevents a distinction between primary and secondary branches. 3–4 rows of zooecial apertures are usually developed on each side of the median carina (keel). Zooecial apertures are usually 0.20 mm long and 0.15 mm wide. Vesicular tissue is developed between autozooecial tubes.

Remarks.—Fragmented zoaria of *Ramipora* are only observed in the uppermost part of the Vøringen Member, in the lithological transition from a bioclastic limestone to a more shaley facies. It is therefore believed that *Ramipora* lived in a deeper, or more protected, quiet water environment, and was washed into the shelly coquinas of the high energy barrier sands. The fragmented nature of the current material prevents a definite species assignment, hence the "cf." denotion. *Ramipora hochstetteri* is abundantly distributed in the upper part of the Kapp Starostin Formation (from where it was originally described by Toula), and a detailed redescription of this species is in preparation by the author.

Material.—AKS–A–11.8m (PMO 118.103, 118.104), FES–10–14.0m (PMO A42066,067), FES–10–15.0m (A42085, 138.082, 138.085), FES–10–20.0m (PMO 41821).

Stratigraphical distribution outside Spitsbergen. – *R. hochstetteri* has been recorded from the "middle" Permian of Tibet (Metz 1946).

Order TREPOSTOMATA

Genus TABULIPORA Young, 1883.

Type species.—Cellepora urii Fleming, 1828, from the Lower Carboniferous of Scotland.

Tabulipora siedleckii Małecki, 1968
Plate 4, Figs. C–H.

1968 *Tabulipora siedleckii* Małecki, pp. 13–21, pl. 1–5, pl. 6, figs. 6, 9, 10, text–figs. 4–6, 8–14.

1988 *Tabulipora siedleckii* Małecki; Nakrem, pp. 114–115.

1992 *Tabulipora siedlecki* [sic] Małecki; Sakagami, pl. 2, figs. 6, 7.

Description.— The investigated material consists of relatively thick cylindrical branching colonies. Twenty specimens were measured, and although the variation in branch diameter is great, they are considered to be monospecific. Most zoaria have a diameter of 6.0–12.0 mm with exozone about 1.0–3.0 mm. Zooecial walls in endozone average 0.02 mm, whereas the walls in exozone vary significantly between 0.05 and 0.15 mm as measured in tangential section. The walls in exozone show a distinct beaded (moniliform) wall structure. Perforated diaphragms occur in varying numbers in zooecial tubes in exozone. They are most common at the endozone–exozone transition where there are up to 4 diaphragms per 1 mm (average 2.5 per 1 mm). Zooecial apertures vary in size, averaging 0.24 mm long and 0.19 mm wide. Distance between aperture centres is about 0.28 mm. About 6 apertures are developed per 2 mm in any direction in tangential section. Exilazooecia (average 0.09 mm in diameter) are not common, usually 1–2 per autozooecial aperture. Large acanthostyles have a diameter about 0.13 mm, and smaller, tubercle-like stylets about 0.02 mm are present. There are 3–4 large acanthostyles per aperture, whereas there are usually 10–30 smaller stylets forming a chain in exozonal walls.

Comparison.—Most of the measured characters show great variation, as was documented by Małecki (1968) in the original description of *T. siedleckii.* Subsequently Morozova & Kruchinina (1986) recorded *T. greenlandensis* Ross & Ross, 1962, *T. arcticensis* Ross & Ross, 1962, and their new species *T. aberrans* Morozova, 1986, from the Kapp Starostin Formation of Svalbard. The great variation in all the above characters observed in the current material include measurements in the above mentioned species, and they should probably be synomised and included in the senior synonym which is *T. greenlandensis*

Measurements.—See Table 4.

Material.—AKS–A–1.3m (PMO A42655–656), AKS–A–3.0m (PMO 118.080), AKS–A–5.0m (PMO 118.071, 118.073), AKS–A–7.0m (PMO A42651), AKS–A–9.0m (PMO A42671), FES–10–1.0m (PMO 118.089), FES–10–6.0m (PMO A42601), FES–10–10.0m (PMO 118.157), FES–10–14.0m (PMO 118.098, 118.102), SVH–2–25.0m (118.082).

Tabulipora sp. A.
Plate 3, Figs. F–H; Plate 4, Figs. A, B.

Description.—Specimens of *Tabulipora* considered to be different from *T. siedleckii* consist of thick irregularly branching colonies, commonly flattened. Colonies are up to 45 mm in diameter, commonly 20–30 mm. Width of exozone varies accordingly between 1.0 and 5.0 mm. Zooecial walls in endozone usually 0.01 mm; moniliform exozonal walls 0.05–0.06 mm thick. Locally in the exozone, there are perforated diaphragms; about 2–3 per 1 mm. Ovate to circular zooecial apertures relatively large, average 0.26 mm long and 0.24 mm wide. Distance between aperture centres is 0.26–0.40 mm as measured in tangential section, and there are usually 6–7 apertures per 2 mm in any direction. Exilazooecia (average diameter 0.09 mm) are rare, usually one per autozooecial aperture when present. There are usually 3–4 large acanthostyles (diameter 0.10–0.20 mm) and a chain of small stylets (0.02 mm in diameter) around each aperture.

Comparison.—*Tabulipora* sp. A. is separated from *T. siedleckii* in growth pattern, branch diameter and autozooecial aperture and exozonal wall dimensions.

Measurements.—See Table 5.

Material.—1–0.01 (PMO 42266–269), KWÆ–1–0.2m (PMO A42155), KWÆ–1–1.55m (PMO A42154, A42157), SVH–basis (PMO 118.086), SVH–2–25.0m (PMO 118.083).

Genus RHOMBOTRYPELLA Nikiforova, 1933.

Type species.—*Rhombotrypella astragaloides* Nikiforova, 1933, from the Middle Carboniferous of the Donetz Basin, Russia.

Remarks.—*Rhombotrypella* is characterized by the square outline of zooecial tubes in endozones observed in transverse section, which distinguishes this genus from *Tabulipora.*

Rhombotrypella alfredensis Morozova, 1986
Plate 5, Figs. A, C, E, G.

1977 *Rhombotrypella* cf. *composita* Nikiforova; Małecki, p. 82, pl. 5, figs. 1a–b.
1986 *Rhombotrypella alfredensis* Morozova *in* Morozova & Kruchinina, p. 49, pl. 13, figs. 1a–c.
1992 *Rhombotrypella alfredensis* Morozova; Sakagami, pl. 4, fig. 1.

Description.—Robust branching cylindrical colonies commonly 4.0–6.0 mm in diameter. Exozone thin, 0.50–1.00 mm wide. Zooecial walls in exozone evenly thickened or beaded; thickness averaging 0.13 mm. Walls in endozone are thin, 0.01 mm. A single hook-like hemiseptum is always present in zooecial tubes in exozone, whereas ordinary diaphragms are extremely rare. Autozooecial apertures ovate in outline, averaging 0.22 mm long and 0.16 mm wide. Distance between aperture centres is 0.16–0.27 mm in longitudinal direction, 0.10–0.23 in transverse or diagonal direction. There are commonly 5–7 apertures per 2 mm in any direction. Exilazooecia are not common, 1 or 2 when present between autozooecial apertures, about 0.06 mm in diameter. Two to four large acanthostyles are developed in aperture junctions being 0.09–0.19 mm in diameter, largest in shallowest section. A chain of smaller acanthostyles is developed in the walls between adjacent apertures, 0.02–0.04 mm in diameter, visible only in shallowest section. Autozooecial tubes have a distinct square outline in endozone in transverse section; 4–6 per 1 mm. Monticules absent.

Comparison.—The measured characters are very similar to the original description of *R. alfredensis*, although the acanthostyles are generally smaller (0.09–0.19 against 0.18–0.27 in Morozova's material). The smaller acanthostyles are significantly smaller than those in *R. insolita* Morozova, 1986. *R. stuckenbergi* Nikiforova, 1938, and *R. invulgata* Trizna, 1948, have greater numbers of ordinary diaphragms in zooecial tubes. *R. holmensis* Ross & Ross, 1962, and *R. mallemukensis* Ross & Ross, 1962, are distinguished in having smaller acanthostyles (diameter 0.07 mm) whereas *R. amdrupensis* Ross & Ross, 1962, has large tuberculate monticules and more common ordinary diaphragms.

Measurements.—See Table 6.

Material.—AKS–A–3.0m (PMO 118.111), AKS–A–5.4m (PMO A42144b, c), AKS–A–7.0m (PMO 118.058, 118.062), AKS–A–8.0m (PMO 118.110), FES–10–1.0m (PMO A42091, 093, 095), KWI–5–2.0m (A42604–606).

Stratigraphical distribution outside Spitsbergen.—Trold Fiord Formation (Upper Permian) of Ellesmere Island and Miseryfjellet Formation (Ufimian) of Bjørnøya, Svalbard (Morozova & Kruchinina 1986).

Rhombotrypella arbuscula (Eichwald, 1860)
Plate 5, Figs. B, D, F, H.

1860 *Stenopora arbuscula* Eichwald, p. 417, pl. 30, fig. 8.
1895 *Geinitzella arbuscula* (Eichwald); Stuckenberg, p. 124, pl. 24, fig. 10.
1938 *Rhombotrypella arbuscula* (Eichwald); Nikiforova, p. 60, pl. 8, figs. 1–4, pl. 9, figs. 1–5.
1986 *Rhombotrypella arbuscula* (Eichwald); Morozova & Kruchinina, p. 47, pl. 11, figs. 2a–c.

Description.—Colonies with finely-branched bifurcating zoaria 1.6–3.7 mm in diameter. Exozone narrow, commonly 0.25–0.40 mm wide. Zooecial walls in endozone 0.02 mm thick; in exozone they are evenly thickened, 0.08–0.11 mm. Ordinary diaphragms in autozooecial tubes are not observed, but a hook-like hemiseptum is present in the transition between endo- and exozone. Autozooecial apertures ovate; 0.18–0.25 mm long and 0.10–0.15 mm wide. Distance between aperture centres is 0.25–0.29 mm. There are about 5–6 apertures per 2 mm along colony and usually more than 7 diagonally or across colony. Exilazooecia, 0.04–0.09 mm in diameter, are rarely developed. Three to four large acanthostyles with diameter 0.07–0.13 mm are present in apertural junctions. A chain of smaller acanthostyles is developed in exozonal walls, diameter 0.02–0.05 mm. Zooecial tubes are square in transverse section, numbering 5–7 per 1 mm.

Comparison.—Branch diameter, exozone width, acanthostyle diameter as well as aperture dimensions distinguish *R. arbuscula* from *R. alfredensis*. *R. distincta* Nikiforova, 1938, originally described as a subspecies of *R. arbuscula* has more widely separated zooecial apertures and smaller acanthostyles.

Measurements.—See Table 7.

Material.—AKS–A–3.0m (PMO 132.082), AKS–A–11.5m (PMO A42686–687) AKS–A–11.8m (PMO 118.103/1, 118.103/4, 118.103/5, 138.118/1–118/5), FES–10–15.0m (PMO A42590, A42276–280, 118.098).

Stratigraphical distribution outside Spitsbergen.—Artinskian and Kungurian of Timan and the Urals (Morozova & Kruchinina 1986).

Genus STENOPORA Lonsdale, 1844
Type species.–Stenopora tasmanensis Lonsdale, 1844, from the Lower Permian of Tasmania, Australia.

Remarks.—Autozooecial tubes with irregularly beaded walls in exozones separate *Stenopora* from *Dyscritella*, whereas lack of diaphragms generally separates *Stenopora* from *Tabulipora.*

Stenopora thula Ross & Ross, 1962
Plate 6, Figs. A–C.

1962 *Stenopora thula* Ross & Ross, pp. 43–44, pl. 13, figs. 1, 3, 4, pl. 17, fig. 12
1992 *Stenopora thula* Ross & Ross; Sakagami, pl. 2, fig. 5

Description.—Relatively robust sub-cylindrical branches with average diameter 4.7 mm. Exozone width average 1.0 mm. Zooecial walls with dark central layer formed by wrinkling of wall lamina. Walls in exozone evenly thickened, showing great variation in thickness; 0.06–0.16 mm. Autozooecial tubes in endozone polygonal in transverse section, wall thickness 0.02 mm. Autozooecial apertures circular and ovate; on average 0.24 mm long and 0.19 mm wide. The apertures are not arranged in particular rows, and there are about 5–6 per 2 mm in any direction. Distance between aperture centres is 0.27–0.40 mm. Exilazooecia usually 0.05–0.10 mm in diameter, 3–4 per aperture. Acanthostyles about 0.05–0.09 in diameter, 6–7 per aperture. Diaphragms in autozooecial tubes extremely rare.

Comparison.—*S. thula* in the current study has several characters in common with and may be conspecific with *S. cidariformis* Lee, 1908.

Measurements.—See Table 8.

Material.—AKS-A-11.0m (PMO 132.085), FES-10-15.0m (PMO A42084, 138.097-101).

Stratigraphical distribution outside Spitsbergen.—Upper part of the Mallemuk Mountain Group (Lower Permian) of eastern North Greenland (Ross & Ross 1962).

Genus DYSCRITELLA Girty, 1911

Type species.–*Dyscritella robusta* Girty, 1911, from the Mississippian (Chester) of Arkansas, North America.

Dyscritella bogatensis Morozova, 1970a
Plate 6, Figs. D–F.

1970a *Dyscritella bogatensis* Morozova, p. 108, pl. 60, fig. 1
1977 *Dyscritella bogatensis* Morozova; Małecki, p. 83, pl. 6, figs. 1a–d.
1977 *Rhombotrypella* cf. *gigantea* Ross & Ross; Małecki, pp. 81–82, pl. 4, figs. 1a–e.
1986 *Dyscritella bogatensis* Morozova; Gilmour & Walker, p. 200, figs. 7d–e, g–h
1986 *Dyscritella maleckii* Morozova *in* Morozova & Kruchinina, p. 55, pl. 16, figs. 2a–c
1988 *Dyscritella bogatensis* Morozova; Nakrem, p. 117.

Description.—Robust cylindrical zoaria 10.0–11.0 mm in diameter. Exozone 1.30–3.30 mm wide, clearly separated from endozone. Zooecial wall thickness in endozone 0.01 mm. Zooecial walls in exozone straight and evenly thickened being 0.05–0.10 mm thick. Diaphragms not observed. Autozooecial apertures ovate or circular in outline and varying in dimensions, commonly 0.20–0.28 mm long and 0.16–0.22 mm wide. Distance between apertural centres is 0.18–0.35 mm. There are usually 5–7 apertures per 2 mm longitudinally and 6–8 per 2 mm diagonally or across colony. Exilazooecia with diameter between 0.06 and 0.15 mm not common, up to 4 around each autozooecium. Acanthostyles with diameter 0.09–0.18 mm, generally 3–4 around each aperture.

Comparison.—The specimens are most similar to those described by Morozova (1970a), and the Svalbard specimens described by Małecki (1977) and Morozova & Kruchinina (1986). The specimens of *D. bogatensis* illustrated in Gilmour & Walker (1986) are quite different from the Spitsbergen specimens in having considerably smaller branch diameters (3.6–3.7 mm), smaller large acanthostyles (0.08 mm) and also in having a larger number of exilazooecia bordering autozooecial apertures. The specimen illustrated in Małecki (1977:pl. 4, fig. 1d) as *Rhombotrypella* cf. *gigantea* displaying evenly thickened walls with large acanthostyles tapering into the surrounding matrix and a single diaphragm in some zooecial tubes and is considered to be *D. bogatensis*.

Measurements.—See Table 9.

Material.—AKS-A-8.0m (PMO 118.064), AKS-A-9.0m (PMO A42668-671).

Stratigraphical distribution outside Spitsbergen.—Upper Permian of the Primor'e region, Russia (Morozova 1970a), and Phosphoria Formation

(Ufimian–Kazanian) of Idaho, North America (Gilmour & Walker 1986).

Dyscritella minuta Morozova, 1986
Plate 6, Figs. G, H; Plate 7, Figs. A, B.

1986 *Dyscritella minuta* Morozova *in* Morozova & Kruchinina, pp. 52–53, pl. 14, figs. 5a–c.

Description.—Delicate, frequently bifurcating colonies with thin branches, usually 1.50–2.00 mm in diameter. Distinct exozone, commonly with a dense appearance due to thick zooecial walls in some areas; exozone width usually 0.30–0.60 mm. Thickness of zooecial walls in exozone about 0.06 mm; in endozone about 0.02 mm. Zooecial apertures ovate, average 0.21 x 0.18 mm. Apertures are more or less arranged in longitudinal rows, numbering about 10 per 2 mm along colony, and 7 diagonally or across colony. Distance between nearest neighbour aperture centres is 0.16–0.20. Exilazooecia vary in abundance, very rare in some places, in other places up to 10 around a single autozooecial aperture. Exilazooecia slightly angular or circular in outline, about 0.04 mm in diameter. Acanthostyles vary significantly in size, being largest in shallowest tangential section; up to 0.11 mm in diameter (average 0.06 mm). There are usually 3–7 acanthostyles per aperture. In maculae there are accumulations of acanthostyles and slit–like exilazooecia and no autozooecia.

Comparison.—This material deviates from the original description of *D. minuta* in having slightly greater branch diameter. Zooecial characters are, however, very similar. *D. minuta* is distinguished from *D. faceta* Kruchinina, 1986, in having smaller apertures and acanthostyles. *D. spinigeriformis* Morozova, 1970a, from the Kazanian of the Russian Platform has thicker branches, larger and more widely spaced zooecial apertures. *D. narjanmarica* Kruchinina, 1973, has thicker branches and a wider exozone, usually with a branch diameter to exozone width ratio as 3:1.

Measurements.—See Table 10.

*Material.*AKS–A–1.3m (PMO A42659–660), AKS–A–9.0m (PMO 132.101), AKS–A–11.5m (PMO A42684, A42687–691), AKS–A–11.8m (PMO 118.103, 132.059–062, 132.118), FES–10–14.0m (PMO 118.096), FES–10–15.0m (PMO A42277–280, 138.036, 138.086, 138.089, 138.094), SVH–basis (PMO 118.086/4A).

Stratigraphical distribution outside Spitsbergen.—Gerke and Savina Groups (Ufimian and Kazanian) of Novaya Zemlya (Morozova & Kruchinina 1986).

Dyscritella sp. A.
Plate 7, Figs. C–F.

1994 ?*Dyscritella* sp., Nakrem, figs. 2a–b

Description.—Small encrusting colonies with maximum thickness 2.3–2.5 mm. Autozooecial wall thickness in exozone averages 0.06 mm, being thicker where acanthostyles are formed. Endozonal wall thickness 0.01–0.02 mm. Autozooecial apertures are rounded or angular being about 0.26–0.34 mm long and 0.26–0.32 mm wide. Distance between aperture centres is 0.35–0.44 mm. There are generally 5–6 apertures per 2 mm in any direction. Exilazooecia are rarely developed and show great variation in diameter (0.04–0.15 mm). Large acanthostyles variable from 0.05–0.13 mm in diameter; 3 per autozooecium. Basal lamina thin; 0.010–0.018 mm thick.

Remarks.—Encrusted substrates include ?*Rhombotrypella* (Pl. 7, Fig. C) and *Polypora* (Fig. 7B), brachiopod shells (Pl. 7, Fig. F), brachiopod spines and crinoid stems (Pl. 7, Fig. E).

Comparison.—This species is different from the Upper Permian *D. incrustata* Morozova, 1970a (also described by Gilmour & Walker 1986) in autozooecial aperture and acanthostyle dimensions. In aperture dimensions and spacing, *D.* sp. A. resembles *D. tubulosa* Morozova, 1970a, which is described as having a tubular (not encrusting) growth form. From Morozova's illustrations, it is, however, possible to infer an encrusting growth habit in the latter species also.

Measurements.—See Table 11.

Material.—KWÆ–1–0.15m (PMO A42271), AKS–A–1.5m (PMO 118.108), AKS–A–9.5m (PMO A42665), AKS–A–11.8m (PMO 132.063/2), FES–10–15.0m (PMO 138.084).

Trepostomata gen. et sp. indet.
Plate 7, Figs. G, H.

Description.—Encrusting zoarium with lamellar and, in places, micrdeveloped granular wall microstructure. Encrusting layer 0.37 to 1.50 mm thick. Zooecial apertures large, up to 0.40 mm long and 0.27 mm wide. Strongly curved, convex diaphragms are developed in zooecial tubes, especially close to basal lamina. Straight diaphragms absent. Exilazooecia, about 0.08–0.10 mm in diameter, apparently without diaphragms are commonly developed between autozooecial apertures. Acanthostyles not observed, but minute stylets produce a microgranular appearance (Pl. 7, Fig. G).

Comparison.—This material shows too few characters to identify the genus. The strongly curved diaphragms have not been detected in any other trepostomatous bryozoans in this study. The minute stylets may indicate a relationship with less advanced trepostomes, e.g. *Anisotrypella*.

Material.—AKS–A–11.8m (PMO 132.057), FES–10–15.0m (PMO 132.120, 138.095)

Order CRYPTOSTOMATA

Suborder RHABDOMESINA

Genus PRIMORELLA Romanchuk & Kiselëva, 1968

Type species.—*Primorella polita* Romanchuk & Kiselëva, 1968, from the Upper Permian of the Maritime Territory, Russia.

Primorella cf. *polita* Romanchuk & Kiselëva, 1968
Plate 8, Figs. A, D, F.

cf. 1968 *Primorella polita* Romanchuk & Kiselëva, p. 57, fig. 2

Description.—Branches are 0.90-1.00 mm in diameter. Zooecial apertures ovate, being 0.20–0.25 mm long and 0.11–0.12 mm wide. 3–4 apertures are present in 2 mm along colony; about 6 in 2 mm diagonally. Distinct acanthostyles form accumulations and undulating chains between apertures. Acanthostyle diameter usually 0.020–0.030, maximum 0.055 mm. Zooecial walls in exozone 0.14–0.15 mm thick; 0.020–0.025 mm in endozone.

Remarks.—Description is based on fragments of *Primorella* from one horizon. The specimens of *P.* cf. *polita* usually occur together with *Clausotrypa monticola* in the current study. The two taxa are not always easily separated in acetate peels, especially in transverse section. Distinguishing features include the regular chain of small acanthostyles contrasting with the light-coloured exozonal walls in *Primorella*, compared with the striated exozonal walls with randomly placed larger acanthostyles in *Clausotrypa*.

Comparison.—Incomplete measurements on the fragmented zoaria prevent conclusive species assignment. The closest species is *P. polita* Romanchuk & Kiselëva, 1968, from the Upper Permian of the Maritime Territory, Russia. *P. barchatova* Kruchinina, 1973, and *P. tundrica* Kruchinina, 1980, both from the Kungurian of Timan, have thicker branches. The former also has larger zooecial apertures.

Measurements.—Measurements and summary statistics are not presented due to too few observations.

Material.—FES–10–15.0m (PMO A42654, 138.075, 138.085, 138.093)

Genus CLAUSOTRYPA Bassler, 1929

Type species.—*Clausotrypa separata* Bassler, 1929, from the Permian of Timor.

Clausotrypa monticola (Eichwald, 1860)
Plate 8, Figs. B, E, G.

1860 *Myriolithes monticola* Eichwald, p. 452, pl. 25, figs. 6a, c.
1938 *Clausotrypa monticola* (Eichwald); Nikiforova, p. 181 [267–268], pl. 64, figs. 4–7, pl. 65, figs. 7–10.
1941 *Clausotrypa monticola* (Eichwald); Shul'ga–Nesterenko, p. 219, pl. 13, figs. 3–6.
1985 *Clausotrypa monticola* (Eichwald); Goryunova, p. 99, pl. 13, fig. 4; text–fig. 33.
1986 *Clausotrypa monticola* (Eichwald); Alekseeva et al., pl. 99, fig. 3.
1986 *Clausotrypa monticola* (Eichwald); Morozova & Kruchinina, p. 67, pl. 20, figs. 3a, b, pl. 4, figs. 4a–c.
1992 *Clausotrypa monticola* (Eichwald); Sakagami, pl. 3, figs. 6, 7.

Description.—Zoaria with thin branches about 0.90–1.10 mm in diameter. Exozone, not easily distinguished from endozone, is commonly 0.20–0.35 mm wide. Thickness of zooecial walls in endozone is 0.020 mm; in exozone highly variable, 0.09–0.24 mm measured in tangential section. Diaphragms are not observed. Zooecial apertures ovate, with great variation in size and inter-apertural distance. Apertures are 0.16 mm long and 0.11 mm wide in shallowest sections widening to 0.29 x 0.13 mm in slightly deeper tangential sections. Distance between apertural centres is about 0.40–0.60 mm along colony and 0.30–0.38 mm diagonally. There are about 3.5 apertures along and 6 apertures diagonally per 2 mm. Angular metapores are infrequently present between zooecial apertures; about 0.036 mm in diameter. When present, there are >8 metapores per zooecial aperture. Distinct acanthostyles projecting above colony surface, 0.03–0.04 mm in diameter are frequently developed between zooecial apertures. Distribution of acanthostyles is random. Small stylets pierce the exozone producing a striated appearance in tangential section.

Remarks.—Dimension of zooecial apertures is highly dependent on how deep are the tangential sections. As can be seen in transverse sections (Pl. 8, Fig. B and G), zooecial tubes are widest some distance away from colony surface. This corresponds to the great variation in exozonal wall thickness and, consequently, aperture openings will vary significantly in size. In their description of *C. monticola*, Morozova & Kruchinina (1986:67) state that "metazooecia [are] absent", but "capillaries" of varying size and shape are present between zooecial apertures.

Comparison.—*C. monticola* is distinguished from *C. spinosa* Fritz, 1932, which was recorded from the Upper Permian of Ellesmere Island and Novaya Zemlya by Morozova & Kruchinina (1986), mainly in its smaller and more closely separated zooecial apertures. Both species have metapores, although Morozova & Kruchinina (1986: p.68) state that "cystopores [=metapores] [are] not developed" in *C. spinosa* as identified by them. *C. clara* Kruchinina, 1980, has no acanthostyles developed. As tabulated in Nakrem (1991b), *C. spinosa* is fairly common in the upper part of the Kapp Starostin Formation of Spitsbergen.

Measurements.—See Table 12.

Material.—Description and measurements are based on 10 fragmented zoaria; AKS–A–11.5m, AKS–A–11.8m, FES–10–14.0m and FES–10–15.0m.

Stratigraphical distribution outside Spitsbergen.—Artinskian of the Urals, Belcher Channel Formation (Asselian–Sakmarian) of Ellesmere Island, Kungurian of Timan and the Malozemel'sk Tundra (Morozova & Kruchinina 1986).

Genus STREBLASCOPORA Bassler, 1952.

Type species.—*Streblotrypa fasciculata* Bassler, 1929, from the Permian of Timor.

Streblascopora germana (Bassler, 1929) Plate 8, Figs. I–K.

1929 *Streblotrypa germana* Bassler, p. 67, pl. 239, figs. 6–10.

1960a *Streblascopora germana* (Bassler); Baranova, p. 68, pl. 4, fig. 4.

1986 *Streblascopora germana* (Bassler); Morozova & Kruchinina, p. 69, pl. 21, figs. 3a–b.

1992 *Streblascopora vera* Morozova; Sakagami, pl. 4, figs. 7–8.

Description.—Bifurcating colonies with branches about 0.80–1.10 mm in diameter. Exozone (0.30–0.40 mm wide) is clearly separated from endozone, with an axial bundle of parallel zooecial tubes (0.20–0.26 mm in diameter). There are 4 parallel zooecia as observed in longitudinal section. Zooecial apertures are elongated ovate, about 0.17–0.18 mm long and 0.09–0.11 mm wide. Distance between centres of apertures is about 0.28 mm diagonally and 0.50 mm along branch; there are about 4 apertures along and 6.5 apertures diagonally per 2 mm. Abundant metapores are developed in the areas between adjacent zooecial apertures. Diameter of metapores is 0.03–0.05 mm; 8–10 metapores are present per zooecial aperture.

Comparison.—*S. germana* is distinguished from *S. fasciculata* Bassler, 1929, in its smaller zooecial apertures, but metapore dimensions are apparently quite similar. *S. kungurensis* Kruchinina, 1986, has a smaller branch diameter and a smaller axial bundle, whereas *S. vera* Morozova, 1986, has a wider axial bundle with six parallel zooecial tubes.

Measurements.—See Table 13.

Material.—Description and measurements are based on 8 fragmented zoaria; AKS–A–11.5m, AKS–A–11.8m, FES–10–14.0m and FES–10–15.0m.

Stratigraphical distribution outside Spitsbergen.— ?Late Permian of Timor (Bassler 1929) and Kungurian of Timan (Morozova & Kruchinina 1986).

Genus PERMOHELOCLEMA Ozhgibesov, 1983

Type species.—Permoheloclema merum Ozhgibesov, 1983, from the Savina Group (Kazanian) of Novaya Zemlya, Russia.

Permoheloclema merum Ozhgibesov, 1983
Plate 8, Figs. C, H.

1983 *Permoheloclema merum* Ozhgibesov, p. 98, figs. 1a–d.
1985 *Permoheloclema merum* Ozhgibesov; Goryunova, p. 94, pl. 5, figs. 3a–c.
1986 *Permoheloclema merum* Ozhgibesov; Morozova & Kruchinina, p. 71, pl. 24, figs. 1a–f.
1992 *Permoheloclema merum* Ozhgibesov; Sakagami, pl. 4, figs. 3–5.

Description.—Finely branched bifurcating colonies with branch diameter about 0.60–0.90 mm, and exozone width about 0.20–0.24 mm. Zooecial apertures ovate, about 0.13 mm long and 0.08 mm wide. Distance between aperture centres is about 0.29 mm along colony and 0.23 mm diagonally. Zooecial apertures are arranged in regular rows along colony, with about 6–8 apertures per 2 mm both diagonally and along colony. Exozonal walls are 0.16 mm thick; endozonal walls about 0.08 mm thick. Exozonal walls are pierced by numerous stylets (diameter 0.01 mm) both randomly arranged and arranged in rows producing a striated or spotty surface as observed in tangential section. Metapores not observed.

Remarks.—Pores [metapores] as mentioned and illustrated in Ozhgibesov (1983: fig. 1a), and mentioned, but not illustrated in Morozova & Kruchinina (1986) were not observed. Most observations were taken from acetate peels; this character may be better visible in petrographic thin sections, as is the case with some characters in cystoporates.

Comparison.—The Artinskian *P. dunaeva* Ozhgibesov, 1983, is distinguished from *P. merum* in having thicker branches (0.83–1.03 mm) and larger zooecial apertures. *P. porifera* (Fritz, 1932) from the Permian of Vancouver Island (Canada) also has thicker branches (1–2 mm).

Measurements.—See Table 14.

Material.—Description and measurements are based on 8 fragmented zoaria; AKS–A–7.0 (PMO A42650/1), AKS–A–11.5m, AKS–A–11.8m, FES–10–10.0m (PMO 118.154–157), FES–10–14.0m and FES–10–15.0m.

Stratigraphical distribution outside Spitsbergen.— Ufimian and Kazanian (Gerke and Savina Groups) in Novaya Zemlya (Morozova & Kruchinina 1986).

Suborder TIMANODICTYOIDEA Morozova, 1966

Genus TIMANODICTYA Nikiforova, 1938

Type species.—Coscinium dichotomum Stuckenberg, 1895, from the Lower Permian of Timan, Russia.

Timanodictya nikiforovae Morozova, 1966
Plate 9, Figs. A–E.

1966 *Timanodictya nikiforovae* Morozova, p. 35, pl. 5, fig. 1.
1970a *Timanodictya nikiforovae* Morozova; Morozova, p. 244, pl. 59, figs. 1a–d.
1977 *Timanodictya nikiforovae* Morozova; Małecki, p. 86, pl. 7, figs. 1a–c.
1986 *Timanodictya nikiforovae* Morozova; Alekseeva et al., pl. 109, figs. 4a–c.
1986 *Timanodictya nikiforovae* Morozova; Morozova & Kruchinina, p. 121, pl. 47, fig.1.
1988 *Timanodictya nikiforovae* Morozova; Nakrem, p. 120
1992 *Timanodictya nikiforovae* Morozova; Sakagami, pl. 5, figs. 1, 2

Description.—Bifoliate ribbon–like branches with zooecia budding from a median lamina opening on both sides of the branches. Thickness of branches usually 1.20–1.70 mm; width about 2.35 mm. Median lamina almost straight, 0.02 mm thick. Zooecia bud at about 90° from the median lamina opening on branch surface in regular oblique rows. Apertures circular or slightly ovate, usually 0.19 x 0.17 mm. An indistinct zooecial lining layer, 0.01 mm wide lines the apertures. Distance between apertural centres along colony is 0.44–0.52 mm, and diagonally 0.29–0.37. There are about 4 apertures per 2 mm along colony and 6 per 2 mm diagonally. Zooecial walls in endozone are 0.02 mm thick. Zooecial wall in exozone is pierced by numerous stylets with a diameter of 0.02 mm; the walls are 0.08–0.13 mm thick.

Comparison.—*T. nikiforovae* is distinguished from *T. obrutschewi* (Nekhoroshev, 1935) and *T. fortis* Morozova, 1970b, in its more widely spaced apertures (2–3 versus 4–6 per 2 mm). *T. fortis* and *T. multifora* Morozova, 1981, have significantly larger stylets (0.03–0.04 mm). *T.* cf. *T. dichotoma* (Stuckenberg, 1895) described from North Greenland (Ross & Ross 1962) has generally thicker branches (average 2.0 mm) and more closely spaced apertures.

Measurements.—See Table 15.

Material.—AKS–A–1.3m (PMO A42695/1), AKS–A–5.0m (PMO 118.078), AKS–A–7.0m (PMO A42650/3), AKS–A–8.0m (PMO A42681), AKS–A–11.5m (PMO A42697), FES–10–10.0m (PMO 118.154–157), FES–10–15.0m (PMO 138.075, 138.092, 138.096, 138.100).

Stratigraphical distribution outside Spitsbergen.—Kazanian of the Russian Platform (Morozova 1966), Gerke Group (Ufimian) of Novaya Zemlya (Morozova & Kruchinina 1986), Miseryfjellet Formation (Ufimian) of Bjørnøya, Svalbard (Małecki 1977).

Genus GIRTYPORINA Morozova, 1966

Type species.—*Girtyporina applicata* Morozova, 1966, from the Upper Permian (Kazanian) of the Russian Platform, Russia.

Girtyporina sp.
Plate 9, Figs. F–H.

Description.—Several small fragments of *Girtyporina* were found during the study. *Girtyporina* is characterized by unilaminar encrusting colonies with well-developed fossazooecia between normal autozooecia. Zoarial components and microstructures are otherwise typically timanodictyine. Specimens were only observed in randomly cut sections, and all necessary features could not be measured. One specimen was attached to a thin brachiopod shell. Autozooecial apertures are regularly circular or slightly ovate, usually 0.21 x 0.20 mm, and distributed in a random pattern. Distance between apertural centres is about 0.30 mm, and there are 6 apertures per 2 mm in any direction. Autozooecial apertures have an indistinct lining 0.016–0.018 mm wide. Maculae, devoid of autozooecia and fossazooecia are developed on colony surface, about 0.96 mm long and 0.27 mm wide. Diaphragms were not observed in zooecial tubes. Exozonal wall thickness is 0.06–0.13 mm.

Remarks.—Stylets are not observed in the current material, but this may be a result of inadequate preservation and acetate peel preparation. Zooecial walls seem to have a microgranular appearance resembling zooecial walls in cystoporates. Other cystoporates, as identified from the current material, do not reveal all microscopic details in acetate peels. There are however no signs of vesicles, and the current material is, therefore, assigned to *Girtyporina*.

Measurements.—See Table 16.

Material.—AKS–A–5.0m (PMO A42678), AKS–A–8.0m (PMO 132.102), AKS–A–11.5 (PMO A42688), FES–10–10.0m (PMO 118.155–156).

Order FENESTRATA

Family FENESTELLIDAE King, 1849

Genus FENESTELLA Lonsdale, 1839

Type species.—*Fenestella antiqua* Lonsdale, 1839, from the Silurian (Wenlock) of Great Britain.

Fenestella akselensis sp. nov.
Plate 10, Figs. A–D.

Diagnosis.—*Fenestella* with elongated box-like to parallelogram shaped zooecial chambers, large monoserial nodes 0.05–0.15 mm long and 0.04–0.10 mm wide, ovate fenestrules and wide branches (0.29–0.39 mm) with a keel along reverse side of branches.

Description.—Meshwork with 15–21 branches per 10 mm across colony and 13–17 fenestrules per 10 mm along colony. Branches with 2 rows of apertures are 0.29–0.39 mm wide; prior to bifurcation branches with 3 rows of apertures are up to 0.49 mm wide. Branch thickness is 0.55 mm. Elongated nodes are present on branch carina, about 0.10 x 0.06 mm; 3.3–4.0 per 1 mm. Distance between node centres is 0.22–0.31 mm. Dissepiments are 0.23–0.35 mm wide. Fenestrules are ovate in outline, 0.36–0.46 mm long and 0.19–0.27 mm wide. Apertures are circular (0.12 mm in diameter) or slightly ovate (0.13 x 0.11 mm) in outline. There are 18–23 apertures per 5 mm along branches, and 3–4 per fenestrule. Distance between aperture centres is about 0.24 mm both along and across branch. Zooecial chambers are irregular kidney–shaped in shallow tangential section, rectangular or boxlike in median to deep tangential section, with a straight axial wall between each row of zooecial chambers. Chamber reverse wall budding angle is 35 – 88° in longitudinal section; inter–colonial variation is clearly larger than intra–colonial variation, but variable orientation of sections also accounts for some variation.

Remarks. – The investigated specimens resemble *Wjatkella* as described by Morozova & Kruchinina (1986) (without preserved protective superstructure) in geometry of fenestrules and the rounded branch–dissepiment junctions.

Comparison.—Fenestella akselensis sp. nov. differs from *F. reversicnotta* sp. nov. in micrometric formula, and in general having a more delicate meshwork. The keel–like development of branch reversals also separates these species. In micrometric composition, the new species has some similarities with *F. accurata* Trizna, 1950, from the Sakmarian of the Urals, and with *F. dispersa* (Crockford, 1943) from the Permian of Australia.

Types.—Holotype AKS–A–5.0m (PMO A42677), acetate peel and rock specimen. Paratype AKS–A–7.0m (PMO A42695), acetate peel and rock specimen.

Type locality.—Akseløya, Svalbard.

Type horizon.—Kapp Starostin Formation, 5.0 metres above the base of the Vøringen Member.

Etymology.—From the place–name Akseløya.

Measurements.—See Table 17.

Material.—AKS–A–5.0m (PMO A42677), AKS–A–7.0m (PMO A42694, A42695, A42696, 118.060, 132.086).

Fenestella reversicnotta sp. nov.
Plate 10, Figs. E–I.

1994 *Rectifenestella* sp., Nakrem, fig. 2f

Diagnosis.—Fenestella with robust meshwork components, relatively closely–spaced zooecial apertures, rectangular to elongated–rounded zooecial chambers and elongated carinal nodes. Robust dissepiments 0.38–0.40 mm wide, slightly sinuous wide branches with large nodes (diameter 0.07–0.10 mm) on reverse side.

Description.—Meshwork with 16–23 branches per 10 mm across colony and 16–20 fenestrules per 10 mm along colony. Branches are usually 0.31–0.37 mm wide, maximum 0.60 mm wide prior to bifurcation where 3 or less commonly 4 rows of apertures are developed, 0.26–0.29 mm wide immediately after bifurcation. Maximum branch thickness is 1.27 mm. Elongated nodes are developed on branch carina, 0.09–0.18 mm long and 0.04–0.07 mm wide. There are about 4 nodes per 1 mm, distance between node centres is 0.18–0.33 mm. Large nodes, diameter 0.07–0.10 mm, are also developed on reverse surface of branches, usually 0.58–0.60 mm apart, in a single row midway along branches. Dissepiments are 0.17–0.30 mm wide, being widest on obverse surface of colony. Fenestrules are 0.32–0.51 mm long and 0.18–0.30 mm wide. Zooecia open inwards into fenestrules leading to an irregular fenestrule outline. There are 19–27 apertures per 5 mm along branches and 2–4 per fenestrule. Distance between aperture centres is about 0.23 mm along branch and 0.22 mm across branch. Apertures are ovate (commonly 0.13 x 0.11 mm) or circular (0.11–0.14 mm in diameter). Zooecial chambers are fabiform in shallow tangential section, elongated–rounded to rectangular in median to deep section. The axial wall is straight to slightly zig–zag. Chamber reverse wall budding angle is 48–63° in longitudinal section.

Remarks.—This species of *Fenestella* resembles *Wjatkella* described without protective superstructure from Svalbard by Morozova & Kruchinina (1986). The geometry of fenestrules and zooecial base outline, as well as branch and dissepiment robustness are similar in both taxa. The complete lack of superstucture, however, prevents placement of the new species in *Wjatkella*.

Comparison.—t–tests revealed significant differences between *Fenestella akselensis* sp. nov. and *Fenestella reversicnotta* sp. nov. regarding branch and dissepiment widths and spacings, as well as apertural spacings. Regarding previously described species of *Fenestella*, the closest species in zoarial characters is *F. enta* Kruchinina, 1973, recorded from the Sakmarian of Timan.

Types.—Holotype AKS–A–5.0m (PMO A42643), acetate peel and rock specimen.

Paratype AKS–A–1.3m (PMO A42658), acetate peel and rock specimen.

Type locality.—Akseløya, Svalbard.

Type horizon.—Kapp Starostin Formation, 5.0 metres above the base of the Vøringen Member.

Etymology.—Combination of revers (reverse side of branches) and cnotta (Anglo–Saxon for knot, node), referring to the frequently developed nodes on the reverse side of branches (Plate 10, Fig. G).

Measurements.—See Table 18.

Material.—AKS–A–1.3m (PMO A42657, A42658), AKS–A–3.0m (PMO 118.081), AKS–A–3.5m (PMO 132.072), AKS–A–5.0m (PMO A42643), AKS–A–10.5m (PMO 132.088, 132.103)

Genus FABIFENESTELLA Morozova, 1974.

Type species.—Fenestella praevirgosa Shul'ga–Nesterenko, 1951, from the Upper Carboniferous (Gzhelian) of the Russian Platform, Russia.

Fabifenestella sp. A.
(not illustrated)

Remarks.—A small fenestellid fragment with fabiform zooecial chambers is assigned to *Fabifenestella.* The meshwork is composed of 14 branches, approximately 0.45 mm wide per 10 mm, and 10 fenestrules per 10 mm along colony. Dissepiments are 0.38–0.45 mm wide. Fenestrules are about 0.60 mm long and 0.36 mm wide. Zooecial apertures are about 0.16–0.18 mm in diameter, about 14–15 per 5 mm along branches. Zooecial chambers are irregular to fabiform in median tangential section.

Comparison.—This description is based on a small fragment of *Fabifenestella*, whose specific affinities cannot be determined. Based on the measured features, the current specimen has, however, characters in common with *F. darvazensis* (Goryunova, 1970) described from the Artinskian of Darvaz, Russia.

Measurements.—Measurements and summary statistics are not presented due to too few observations.

Material.—AKS–A–7.0m (PMO 118.109).

Fabifenestella sp. B.
Plate 11, Figs. A, B.

Remarks.—Relatively loose meshwork with irregular elongated fenestrules. There are 7–9 branches across and 5–7 fenestrules along colony in 10 mm. Branches are 0.45–0.55 mm wide with 2.5–3 indistinct nodes per 1 mm. The nodes are 0.09 mm long and 0.06 mm wide. Distance between node centres is about 0.38 mm. Dissepiments are 0.38–0.40 mm wide. Fenestrules are 1.18–1.77 mm long, and 0.64–0.84 mm wide. Apertures are circular, 0.14–0.15 mm in diameter. There are usually 13–15 apertures per 5 mm along branches, and 6–7 bordering each fenestrule. Distance between aperture centres is 0.31–0.36 mm along branch; 0.3[illegible]–0.46 across branch. Zooecial chambers are ovate fabiform in shallow to median tangential section, and more rectangular in deeper section.

Comparison.—Most measured characters display great variation, and a species assignment is not possible from the current material. Regarding the micrometric formula, *F. completa* Morozova, 1986, recorded from the Kocherga and Gerke Groups (Ufimian) of Novaya Zemlya, is the closest species.

Measurements.—See Table 19.

Material.—AKS–A–11.8m (PMO 118.105).

Genus RECTIFENESTELLA Morozova, 1974

Type species.—Fenestella medvedkensis Shul'ga–Nesterenko, 1951, from the Upper Carboniferous (Kasimovian) of the Russian Platform, Russia.

Rectifenestella microporata (Shul'ga–Nesterenko, 1939)
Plate 11, Figs. C–F.

1939 *Fenestella elegantissima* Eichwald var. *microporata* Shul'ga–Nesterenko, p. 67, text–fig. 21.

1941 *Fenestella elegantissima* Eichwald var. *microporata* Shul'ga–Nesterenko; Shul'ga–Nesterenko, p. 69, pl. 7, fig. 3, pl. 8, fig. 3.

1941 *Fenestella elegantissima* Eichwald var. *cornifera* Shul'ga–Nesterenko, p. 71, pl. 9, figs. 1–2.

1981 *Rectifenestella microporata* (Shul'ga–Nesterenko); Morozova, p. 65, pl. 15, fig. 5, pl. 29, fig. 3.

1986 *Rectifenestella microporata* (Shul'ga–Nesterenko); Morozova & Kruchinina, p. 80, pl. 28, fig. 3.

Description.—Meshwork with 20–28 branches per 10 mm across colony and 18–23 fenestrules per 10 mm along colony. Branches with two rows of apertures are about 0.24 mm wide, usually wider (0.30 mm) near obverse surface of colony and narrowing (0.18 mm) towards reverse side. Branches are 0.83–1.18 mm thick. Nodes are consistently present along branch carina, 4–6 per 1 mm. Nodes are elongated, commonly 0.07 x 0.05 mm; average distance between node centres is 0.21 mm. Dissepiments are about 0.23 mm wide, but show great variation (0.08–0.38 mm) being wider on obverse than on reverse side. Fenestrules are about 0.29 x 0.18 mm, but as in dissepiment dimensions, variation is great due to possible secondary calcification leading to a decrease in fenestrule size. Some fenestrules are completely closed off (Pl. 11, Fig. C). Apertures are circular or slightly ovate in outline, commonly 0.12 x 0.09 mm. There are 20–30 apertures per 5 mm along branches, and 2–3 apertures bordering each fenestrule. Distance between aperture centres is 0.16–0.24 mm along branch; 0.20–0.26 mm across branch. Zooecial chambers in median tangential section are pentagonal, with a zig-zag axial wall between each row of zooecial chambers. Chamber reverse wall budding angle about 70° in longitudinal section, but variation is great.

Comparison.—R. microporata is distinguished from *R. retiformis* (Schlotheim, 1816) which has smaller fenestrules and more closely spaced apertures. Possible secondary calcification of branches and dissepiments and the partial closing off of fenestrules are features in common with *Lyropora serissima* sp. nov., but *R. microporata* is generally less robust than *Lyropora serissima* sp. nov.; dissimilarity is also supported by differences in micrometric formula as well as the arched shape of zoaria in *Lyropora*.

Measurements.—See Table 20.

Material.—AKS-A-1.5m (PMO 118.108), AKS-A-3.0m (PMO A42667, PMO 118.053, 118.054), AKS-A-5.0m (PMO 118.074), AKS-A-7.0m (PMO A42640, A42683), AKS-A-11.5m (PMO A42693, PMO 132.098), FES-10-6.0m (PMO 118.158).

Stratigraphical distribution outside Spitsbergen.—*R. microporata* is recorded from the Sakmarian of the Urals and the Artinskian "Unnamed Formation" of Ellesmere Island (Morozova & Kruchinina 1986).

Rectifenestella retiformis (Schlotheim, 1816)
Plate 11, Figs. G, H; Plate 12, Figs. A, B.

1816 *Keratophytes retiformis* Schlotheim, p. 17, pl.1, figs. 1–2.
1849 *Fenestella retiformis* (Schlotheim); King, p. 35, pl. 2, figs. 8–19.
1861 *Fenestella retiformis* (Schlotheim); Geinitz, p. 116, pl. 22, fig. 1.
1926 *Fenestella retiformis* (Schlotheim); Likharew, p. 1012, pl. 14, figs. 1–5,7,8,10, pl. 15, figs. 2–4,6, text-figs. 1–3.
1930 *Fenestella retiformis* (Schlotheim); Korn, p. 354, pl.1, figs. 1–4.
1930 *Fenestella retiformis* (Schlotheim); Shul'ga-Nesterenko, pl. 6, fig. 6.
1939 *Fenestella retiformis* (Schlotheim); Shul'ga-Nesterenko, p. 71, pl. 13, figs. 2, 4, 5; text-fig. 26.
1941 *Fenestella retiformis* (Schlotheim); Shul'ga-Nesterenko, p. 77, pl. 10, fig. 3, pl. 11, figs. 5–6.
1948 *Fenestella retiformis* (Schlotheim); Trizna, p. 164, pl. 13, figs. 5–6.
1961 *Fenestella retiformis* (Schlotheim); Dreyer, p. 9, pl. 1, figs. 1–2, pl. 2, figs. 1–5, pl. 3, fig. 1, text-fig. 1.
1968 *Fenestella retiformis* (Schlotheim); Sakagami, p. 57, pl. 9, fig.5.
1970a *Fenestella retiformis* (Schlotheim); Morozova, p. 162, pl. 30, fig. 2, pl. 32, fig. 2.
1981 *Rectifenestella retiformis* (Schlotheim); Morozova, p. 66, pl. 16, fig. 1, pl. 29, fig. 4.
1983 *Fenestella retiformis* (Schlotheim); Yang & Lu, p. 278, pl. 3, figs. 11–12.
1986 *Rectifenestella retiformis* (Schlotheim); Alekseeva et al., pl. 101, fig. 1.
1986 *Rectifenestella retiformis* (Schlotheim); Morozova & Kruchinina, p. 80, pl. 28, fig. 4.

Description.—Meshwork with 19–20 branches per 10 mm across colony and 15–17 fenestrules per 10 mm along colony. Branches are 0.20–0.36 mm wide and 0.91 mm thick. Large nodes (0.09–0.18 x 0.07–0.09 mm) are present on branch carina; 4 per 1 mm. Dissepiments are 0.12–0.24 mm wide. Fenestrules are 0.38–0.47 mm long and 0.18–0.30

mm wide. Apertures are circular, 0.09 mm in diameter; distance between aperture centres is 0.11–0.24 mm along branch, and 0.24–0.31 mm across branch. There are 16–23 apertures per 5 mm along branches, with 2.5–3 apertures per fenestrule. Zooecial chambers have an irregular ovate outline in shallow tangential section, more pentagonal in median tangential section. Chamber reverse wall budding angle is 61–71° in longitudinal section. Appendages (root holdfasts) are commonly developed and originate from the branch reverse (Pl. 12, Fig. B).–

Comparison.—The calculated micrometric formula falls within the ranges of *R. retiformis* as documented in several previous works. The species is separated from *R.* sp. A. which has more closely spaced apertures. *R. nikiforovae* (Shul'ga–Nesterenko, 1936) from the Lower Permian of Timan, and *R. veneris* (Fischer de Waldheim, 1837) of Carboniferous age also fall within the recorded ranges of zoarial characters in *R. retiformis*.

Measurements.—See Table 21.

Material.—AKS–A–7.0m (PMO 132.075), FES–10–15.0m (PMO 138.080/2).

Stratigraphical distribution outside Spitsbergen.—*R. retiformis* has a long stratigraphic range, from the Artinskian of the Urals (Shul'ga–Nesterenko 1941) to the Ufimian of Ellesmere Island (Morozova & Kruchinina 1986) and the lower Zechstein of Europe (Schlotheim 1816; Dreyer 1961; Morozova 1970a).

Rectifenestella sp. A.
Plate 12, Figs. C–E.

Description.—Meshwork with 18–23 branches per 10 mm across colony and 14–17 fenestrules per 10 mm along colony. Branches are 0.25–0.33 mm wide, and 0.40 mm thick. Nodes are present on branch carina, 4–5 per 1 mm. Nodes are elongated, average 0.11 x 0.06 mm, largest in shallower section. Distance between node centres is 0.20–0.25 mm. Dissepiments are 0.15–0.22 mm wide. Fenestrules are 0.38–0.55 mm long, 0.22–0.31 mm wide. Apertures are circular in outline; 0.10–0.13 mm in diameter. Distance between aperture centres is 0.16–0.22 mm along branches, 0.12–0.22 mm across branches. There are 3.5–4.0 apertures bordering each fenestrule, 24–30 per 5 mm along branches. Zooecial chambers are irregular or ovate in shallow tangential section, pentagonal in median and deep tangential section. Chamber reverse wall budding angle 55–65° in longitudinal section.

Comparison.—*R.* sp. A. differs from *R. retiformis* in having significantly more closely–spaced zooecial apertures (24–30 against 16–20 per 5 mm), and greater number of apertures bordering each fenestrule (3.5–4.0 versus 2.5–3.0). *R.* sp. A. is distinguished from *R. microporata* which has smaller fenestrules and fewer apertures bordering each fenestrule. *R.* sp. A. has a micrometric formula which has some components in common with *R. medvedkensis* (Shul'ga–Nesterenko, 1951) from the Kasimovian (Carboniferous) and *R. pseudoveneris* (Shul'ga–Nesterenko, 1941) from the Sakmarian–Artinskian of the Urals, but is distinguished in having larger and more widely spaced zooecial apertures. Shortage of well–preserved specimens prevents, however, erection of a new species.

Measurements.—See Table 22.

Material.—AKS–A–7.0m (PMO 118.059), FES–10–15.0m (PMO A42086, A42087, A42089, 138.090)

Rectifenestella sp. B.
Plate 12, Fig. F.

Description.—Meshwork with an open character, with 12–13 branches and 8–9 fenestrules per 10 mm. Branches have a sinuous shape, being 0.24–0.36 mm wide with 4 nodes per 1 mm. Nodes are 0.08–0.09 mm long and 0.05–0.07 mm wide. The branches are striated on reverse side. Dissepiments are 0.25 mm wide near obverse surface and 0.16 mm near reverse surface of colony. The dissepiments frequently bear small tubercles with a diameter of 0.014–0.016 mm. Fenestrules are ovate and unusually large, 1.00–1.14 mm long and 0.55–0.66 mm wide. Zooecial apertures are circular, with a diameter of 0.09–0.10 mm. Distance between aperture centres is 0.20–0.22 mm along and across branch, with 21–24 apertures in 5 mm. There are 5, or usually 6 apertures bordering each fenestrule. Zooecial chambers are pentagonal or slightly triangular in median tangential section.

Comparison.—The large, elongated fenestrules and the large number of apertures bordering each fenestrule separate *R.* sp. B. from all other known species of *Rectifenestella*. Shortage of well preserved specimens prevents, however, erection of a new species.

Measurements.—See Table 23.

Material.—FES–10–15.0m (PMO A42085, 138.075, 138.080/1)

Genus ALTERNIFENESTELLA Termier & Termier, 1971
(=*Mirandifenestella* Termier & Termier, 1971)

Type species.—*Fenestella minor* Nikiforova, 1933, from the Middle Carboniferous of the Donetz Basin, Russia.

Alternifenestella bifida (Eichwald, 1860)
Plate 12, Fig. H.

1860 *Fenestella bifida* Eichwald, p. 354, pl. 23, fig. 6.
1895 *Fenestella bifida* Eichwald; Stuckenberg, p. 144, pl. 21, fig. 7.
1938 *Fenestella bifida* Eichwald; Nikiforova, p. 78, pl. 14, figs. 6–9, text–fig. 40.
1939 *Fenestella bifida* Eichwald; Shul'ga–Nesterenko, p. 67, pl. 11, figs. 6–7.
1941 *Fenestella bifida* Eichwald; Shul'ga–Nesterenko, p. 119, pl. 26, fig. 4, pl. 28, figs. 3–4.
1949 *Fenestella bifida* Eichwald; Shul'ga–Nesterenko, pl. 4, fig. 11, pl. 7, fig. 6.
1986 *Alternifenestella bifida* (Eichwald); Morozova & Kruchinina, p. 83, pl. 30, fig. 4.

Description.—Regular meshwork with 12.5–13 branches per 10 mm across colony, and 9.5–10 fenestrules per 10 mm along colony. Branches are 0.25–0.38 mm wide, bearing a zig–zag row of monoserial nodes; 1.5–2 per 1 mm. The nodes are circular, with diameter 0.11 mm in shallowest section, being more elongated (0.15 x 0.07 mm) in deeper tangential section. Distance between node centres is 0.53–0.62 mm. Tubercles are developed on reverse side of branches, being 0.035–0.055 mm in diameter; 7–8 per 1 mm. Dissepiments are 0.16–0.20 mm wide. Fenestrules are 0.82–0.89 mm long and 0.42–0.47 mm wide. Apertures are circular with diameter of 0.11–0.12 mm. 3–4 apertures border each fenestrule, and there are about 16 per 5 mm. Distance between aperture centres is about 0.30 mm along and 0.27 mm across branches. Zooecial chambers are triangular to trapezoidal in median to deep tangential section.

Comparison.—This specimen matches very closely with previously described species of *A. bifida*, although the number of apertures bordering each aperture is 3–4 instead of 3, and the spacing of nodes is slightly greater. *A. bifida* has some similarities with *A. greenharbourensis* (Nikiforova, 1936), but is distinguished in having a larger inter–aperture distance, as well as larger fenestrules.

Measurements.—See Table 24.

Material.—FES–10–15.0m (PMO 132.121)

Stratigraphical distribution outside Spitsbergen.—Sakmarian – Artinskian of the Urals and Timan (Shul'ga–Nesterenko 1941; Nikiforova 1938), Gerke Group (Ufimian) of Novaya Zemlya (Morozova & Kruchinina 1986).

Alternifenestella cf. *greenharbourensis*
(Nikiforova, 1936)
Plate 13, Fig. A.

cf. 1936 *Fenestella greenharbourensis* Nikiforova, p. 118, pl. 1, figs. 4–6.
cf. 1986 *Alternifenestella greenharbourensis* (Nikiforova); Morozova & Kruchinina, p. 85, pl. 31, fig. 2a–b.
cf. 1992 *Alterifenestella* [sic] *greenharbourensis* (Nikiforova); Sakagami, pl. 5, fig. 6.

Description.—Meshwork with about 14–15 branches across, and 10–11 fenestrules along colony per 10 mm. Branches are 0.35 mm wide in median tangential section, narrowing to 0.29 mm on reverse side. The reverse side of the branches are weakly striated with abundant irregularly distributed small tubercles (0.018–0.022 mm in diameter). Dissepiments are 0.20–0.21 mm wide; 0.16 mm on reverse side. Fenestrules are 0.73–0.82 mm long and 0.38–0.45 mm wide. Zooecial chambers are triangular and trapezoidal in median to deep tangential section. There are 18–19 chambers per 5 mm along branch; 4 per fenestrule.

Remarks.—Insufficient material was obtained for description, and characters in shallow tangential section (nodes and apertures) could not be obtained.

Measurements.—See Table 25.

Material.—AKS–A–11.8m (PMO 132.063/1), FES–10–15.0m (PMO 132.084, 132.121).

Stratigraphical distribution outside Spitsbergen.—*A. greenharbourensis* is previously known from the Gerke Group (Ufimian) of Novaya Zemlya (Morozova & Kruchinina 1986).

Alternifenestella cf. *minuscula* Morozova, 1986
Plate 12, Fig. I.

cf. 1986 *Alternifenestella minuscula* Morozova *in* Morozova & Kruchinina, pp. 83–84, pl. 30, fig. 3.

Description.—*Alternifenestella* with minute meshwork with closely-spaced branches and relatively small fenestrules. There are 20–26 branches across and 16–17 fenestrules along colony per 10 mm. Branches are 0.29–0.31 mm wide and about 0.29 mm thick; nodes are not observed. Dissepiments are 0.13–0.18 mm wide. Fenestrules are 0.35–0.40 mm long and 0.20–0.24 mm wide. The fenestrules are irregular in outline in shallow tangential section due to projecting zooecial apertures. Zooecial apertures are circular with diameter of 0.09–0.10 mm. Two apertures border each fenestrule, and there are 16–18 per 5 mm along branch. Distance between aperture centres is about 0.25–0.30 mm both along and across branch. Zooecial chambers are irregular ovate and triangular in shallow to median tangential section, and trapezoidal in deep section.

Remarks.—The identification is based on a small fragment.

Comparison.—This specimen is most similar to *A. minuscula*; only the length of the fenestrules and consequently the dissepiment spacing differs slightly. It differs from *A.* sp. A. in having distinctly shorter fenestrules and an overall finer meshwork.

Measurements.—See Table 26.

Material.—AKS–A–11.8m (PMO 132.118).

Stratigraphical distribution outside Spitsbergen.—*A. minuscula* is described from the Ufimian Gerke Group of Novaya Zemlya (Morozova & Kruchinina 1986).

Alternifenestella subquadratopora (Shul'ga–Nesterenko, 1952)
Plate 12, Fig. G.

1952 *Fenestella subquadratopora* Shul'ga–Nesterenko, p. 47–48, pl. 9, fig. 5

1975a *Fenestella subquadratopora* Shul'ga–Nesterenko; Goryunova, p. 84, pl. 19, fig. 3, pl. 20, fig. 1.

Description.—*Alternifenestella* with very regular meshwork. There are 18–19 branches across and 18–19 fenestrules along colony per 10 mm. The branches are usually 0.31 mm wide; 0.45 mm prior to bifurcation and 0.24 immediately after bifurcation. Nodes are developed on branch carina, numbering 3.5–4 per 1 mm. The nodes are 0.09–0.11 mm long and 0.06–0.08 mm wide, with a distance of 0.25–0.29 mm from centre to centre. Nodes are also developed on reverse side of branches, usually at branch–dissepiment junctions, but also between such junctions. The reverse nodes are small, 0.04–0.05 mm in diameter; 2.5–3 nodes per 1 mm. Dissepiments are about 0.11 mm wide. Fenestrules are about 0.45 mm long and 0.27 mm wide. Apertures are slightly ovate in outline, measuring 0.13 x 0.12 mm. Distance between aperture centres is 0.27–0.29 mm along and 0.25–0.27 mm across branch. There are 18–19 apertures per 5 mm along branches, and 2–2.5 bordering each fenestrule. Autozooecial chambers are ovate or fabiform with a single hemiseptum in shallowest tangential section, and triangular to trapezoidal in deeper section.

Comparison.—The current specimens match closely the morphometrics of previously described specimens of *A. subquadratopora*:
Spitsbergen specimens: 17–19/17–19/18–19/2–2.5
Lower Permian, Urals
(Shul'ga–Nesterenko 1952):18/16–17/17–18/2.5
Artinskian, Pamir
(Goryunova 1975a):18/16–17/16–18/1.5–2

Measurements.—See Table 27.

Material.—FES–10–15.0m (PMO 132.121/2, 138.083/1).

Stratigraphical distribution outside Spitsbergen.—Lower Permian of the Urals (Shul'ga–Nesterenko 1952) and Artinskian of Pamir, Russia (Goryunova 1975a).

Alternifenestella sp. A.
Plate 13, Figs. B, C.

Description.—Alternifenestella with relatively open meshwork with 8–9 branches and 5–6 fenestrules per 10 mm. Branches are 0.40–0.60 mm wide, being narrowest close to reverse side. The branches carry large, 0.22 mm long and 0.16 mm wide, carinal nodes, about 1–1.5 per 1 mm. Distance between node centres is 0.65–0.78 mm. The reverse side of branches carry abundant small stylets, measuring 0.010–0.014 mm in diameter. Dissepiments are 0.22–0.38 mm wide. Fenestrules are large, being 1.36–1.41 mm long and 0.68–0.76 mm wide. Apertures are distinctly ovate in outline, measuring 0.16 x 0.14 mm. Distance between aperture centres is 0.27–0.29 mm along and 0.30–0.34 mm across branch. There are 15–17 apertures per 5 mm; 5–6 bordering each fenestrule. Autozooecial chambers are irregularly ovate in shallow tangential section, and more triangular and trapezoidal in median to deep section.

Comparison.—This species is distinguished from most other species of *Alternifenestella* in the long fenestrules and the large number of apertures bordering each fenestrule. Other species with similar features and micrometric formulae include:

A. invisitata Morozova, 1986 (Ufimian, Novaya Zemlya): 6–7/4–6/13–15/6

A. kuzminensis (Shul'ga–Nesterenko, 1952) (Sakmarian, Urals): 8/5/15/6

A. multiporataeformis (Shul'ga–Nesterenko, 1939) (Sakmarian, Urals) : 9–10/4–5/14–15/5–6

Shortage of well preserved specimens prevents, however, erection of a new species.

Measurements.—See Table 28.

Material.—FES–10–15.0m (PMO 132.121/1, 138.075, 138.076).

Genus *LYROPORA* Hall, 1857

Type species.–Fenestella [Lyropora] subquadrans Hall, 1857, from the Upper Mississippian (Chester) of Illinois, North America.

Remarks.—Lyropora has a fenestrate zoarium characterized by strongly calcified margins and an arched *Polypora*–like meshwork between. The generic descriptions of *Lyropora* Hall, 1857, and *Lyroporella* Simpson, 1895, were based on the same type specimen, and *Lyroporella* should be recognized as junior synonym of *Lyropora* (F. K. McKinney, pers. comm. 1992).

Lyropora serissima sp. nov.
Plate 13, Figs. D–H; Plate 14, Figs. A–D.

Diagnosis.—Arched, longitudinally ridged zoarium; minute, closely–spaced branches with relatively large monoserial carinal nodes and two rows of small apertures with peristomal stylets; small fenestrules; pentagonal autozooecial chambers in median tangential section.

Description.—Meshwork with 23–29 branches per 10 mm across colony, and 20–25 fenestrules per 10 mm along colony. Branches usually 0.22–0.29 mm wide; 0.31–0.42 immediately prior to bifurcation and 0.16–0.20 mm after bifurcation. Colony and branch thickness varies, but one specimen has a maximum thickness of about 2.2 mm. Bulb–shaped monoserial nodes are arranged on weakly developed carina; largest (maximum 0.23 x 0.13 mm) in shallowest section, normally 0.11 x 0.09 mm; distance between node centres is 0.19–0.26 mm, and there are 4–5 nodes per 1 mm along carina. Reverse sides of branches are packed with small tubercles; about 0.015–0.020 mm in diameter. Dissepiments are 0.15–0.30 mm wide. Both branches and dissepiments are wider on obverse than on reverse side of colony. Fenestrules are 0.18–0.33 mm long and 0.14–0.18 mm wide; intracolonial variation is small whereas intercolonial variation is relatively large. Fenestrules are commonly closed off by secondary calcification producing a massive appearance. Apertures are circular in outline, 0.09–0.11 mm in diameter; 23–30 per 5 mm in two rows along branch. There are 2.5–3 apertures bordering each fenestrule. 8 stylets are bordering each aperture, observed only in shallowest tangential section (Pl. 13, Fig. F). Distance between apertural centres along branch is about 0.18 mm; across branch 0.21 mm. Autozooecial chambers have a pentagonal outline in median tangential section. Chamber reverse wall budding angle 66–75° in longitudinal section.

Remarks.—The current species is placed in *Lyropora* because of the many common features, e.g. arched, probably lyre–shaped zoarium, autozooecia opening on convex side of zoarium, laminated skeletal layers blocking off fenestrules, and broad robust dissepiments and branches. All the colonies are embedded in limestone matrix, but a lyre–shaped growth is likely (Pl. 14, Fig. A). Autozooecial apertures open on the outer convex surface of colony and this is in agreement with species of *Lyropora* described by McKinney (1978). The robust skeletal composition of the present species of *Lyropora* reflects its autecology as it lived in a shallow water environment with strong wave action.

Comparison.—Skeletal dimensions in *Lyropora serissima* sp. nov. is similar to species of *Lyropora* described from the Chester Series (Lower Carboniferous) of North America (McFarlan 1942; McKinney 1978). Although variation is great, the measured zoarial characters in the Spitsbergen species are, however, more minute. Zooecial base in tangential section is also slightly different being more pentagonal in *Lyropora serissima* sp. nov. Colony robustness and geometry of zooecial bases in *Lyropora serissima* sp. nov. and species of *Rectifenestella* in the present study are superficially similar, but t–tests revealed significant differences ($p<0.0005$ for branch and dissepiment spacings). *Lyropora serissima* sp. nov. is also significantly different from *R. retiformis* and *R. microporata* in zooecial apertures per 5 mm, but there is no statistical difference between *Lyropora serissima* sp. nov. and *Rectifenestella* sp. A. using this character.

Types.—Holotype KWÆ–1–1.55m (PMO A42152/1–3), acetate peels and rock specimen. Paratype KWÆ–1–0.15m (PMO A42274), petrographic thin section.

Type locality.—Kapp Wijk, Spitsbergen Svalbard.

Type horizon.—Kapp Starostin Formation, 1.55 metres above the base of the Vøringen Member.

Etymology.—From *serus* (Latin), meaning late, happening late, referring to the young age of the new species.

Measurements.—See Table 29.

Material.—KWÆ–1–0.15m (PMO A42158, A42274), KWÆ–1–1.55m (PMO A42152), KWÆ–1–1.8m (PMO A42150).

Genus PENNIRETEPORA d'Orbigny, 1849

Type species.—*Retepora pluma* Phillips, 1836, from the Lower Carboniferous of Yorkshire, England.

Penniretepora sp. A.
(not illustrated)

Remarks.—Small fragments of *Penniretepora* were identified in a single sample. The main branch is 0.38–0.46 mm wide, with side (secondary) branches 0.24–0.27 mm wide. Distance between centres of side branches is 0.91–0.93 mm. Apertural outlines were not observed due to the rather deep tangential section; zooecial bases are pentagonal to triangular in median section. There are 17–18 apertures per 5 mm along branches, with 2–3 between each side branch. Nodes are questionably present, 0.05–0.06 mm in diameter being 0.30 mm apart measured from node centre to centre (3.5 per 1 mm).

Comparison.—No previously described species of *Penniretepora* matches the Spitsbergen specimens. The current species has, however, features in common with *P. trapezoidea* (Trizna) described from the Sakmarian–Artinskian of the Urals (Trizna 1939) which has 10 side branches per 10 mm and 16–17 apertures per 5 mm. Both main and side branches are narrower. Insufficient material prevents erection of a new species.

Measurements.—Measurements and summary statistics are not presented due to too few observations.

Material.—AKS–A–11.8m (PMO 132.118/2, 132.119)

Penniretepora sp. B.
Plate 15, Fig. A

Remarks.—A small fragment of *Penniretepora* with a main branch about 0.51 mm wide in median tangential section. Side branches are 0.29–0.30 mm wide. Distance between side branches, measured from centre to centre is 1.04–1.13 mm. There are about 9 side branches per 10 mm. Autozooecial chambers are ovate to triangular in median section, and trapezoidal in deepest tangential section. There are 12.5–13 autozooecial chambers per 5 mm on main branch, and 14.5 on side branches. 2.5–3 chambers are present on main branch between each side branch. Apertures and possible nodes were not observed due to section orientation.

Comparison.—Several previously described species of *Penniretepora* have a similar spacing of side branches and zooecial apertures. The closest species is *P. praetenuis* (Trizna) described from the Sakmarian of the Urals (Trizna 1950), but insufficient material from Spitsbergen prevents assignment to a species.

Measurements.—Measurements and summary statistics are not presented due to too few observations.

Material.—FES–10-15.0m (PMO 132.077).

Family POLYPORIDAE Vine, 1884

Genus POLYPORELLA Simpson, 1895

Type species.—Fenestella fistulata Hall, 1885, from the Middle Devonian (Hamilton Group), North America.

Polyporella biarmica (Keyserling, 1846)
Plate 15, Figs. B, D.

1846 *Polypora biarmica* Keyserling, p. 191, pl. 3, fig. 10
1895 *Polypora biarmica* Keyserling; Stuckenberg, p. 158, pl. 23, figs. 1a–b
1938 *Polypora biarmica* Keyserling; Nikiforova, p. 240, pl. 23, figs. 1–7
1939 *Polypora biarmica* Keyserling; Shul'ga–Nesterenko, p. 72–73, fig. 30
1948 *Polypora biarmica* Keyserling; Trizna, p. 164, pl. 15, figs. 1–4

Description.—Meshwork with 8.5 to 10 branches per 10 mm across colony and 7–8 fenestrules per 10 mm along colony. Branches 0.55–0.60 mm wide, with 3 rows of apertures. Prior to bifurcation, branches with 4 rows of apertures are 0.64–0.73 mm wide, whereas immediately after bifurcation branches with 2 rows of apertures are 0.41 mm wide. Small nodes, 0.06–0.07 mm in diameter, are developed on carinal ridge between rows of apertures. Distance between nodes is about 0.31 mm; usually 3–3.5 per 1 mm along branch. Dissepiments are 0.27 to 0.39 mm wide. Fenestrules are 1.00–1.14 mm long, 0.32 to 0.55 mm wide. Apertures are ovate in outline (0.13–0.15 x 0.09–0.11 mm); about 16–17 per 5 mm. Distance between apertural centres is 0.23–0.25 mm along branch, and 0.25–0.27 across branch. In median tangential section, autozooecial chambers in middle row have an hexagonal outline whereas those in marginal rows have a pentagonal outline.

Remarks.—The area where the specimen was measured is close to the proximal part of the colony and branches diverge and bifurcate frequently.

Comparison.—P. biarmica is distinguished from *P. borealis* (Stuckenberg, 1895) in having larger fenestrules and consequently more widely spaced branches and dissepiments, and from *P. micropora* (Stuckenberg, 1895) in having larger nodes (0.06–0.07 mm versus 0.02–0.03 mm) and more elongated fenestrules.

Measurements.—See Table 30.

Material.—AKS–A–4.5m (PMO 132.097).

Stratigraphical distribution outside Spitsbergen.—*P. biarmica* is recorded from the Artinskian of Timan (Nikiforova 1938) and the Artinskian Reefs of the Urals (Trizna 1948).

Polyporella borealis (Stuckenberg, 1895)
Plate 14, Figs. E–H.

1895 *Polypora borealis* Stuckenberg, p. 162, pl. 23, fig. 5.
1938 *Polypora borealis* Stuckenberg; Nikiforova, p. 112, pl. 19, figs. 4, 5, pl. 20, figs. 1–2.
1986 *Polyporella borealis* (Stuckenberg); Morozova & Kruchinina, p. 99, pl. 35, figs. 5a–b.

Description.—Zoarium is funnel–shaped, commonly low and wide with a robust appearance. Meshwork with 10–16 branches per 10 mm across colony and 10–12 fenestrules per 10 mm along colony. Large variation in branch spacing across colony is due to some measurements being made close to colony origin. Width of branches with 3 rows of apertures is 0.46–0.65 mm, branches with 4 rows 0.68–0.80 mm wide, and branches with 2 rows 0.31–0.36 mm wide. Branches commonly undulating, connected by very short dissepiments. Branch thickness at least 0.82 mm measured away from nodes. Nodes are usually evenly distributed along carina between apertural rows, but randomly placed nodes are also common. Nodes are bulb–shaped, with greatest diameter in shallowest tangential section (0.22 x 0.13 mm); more normal size is 0.12 x 0.09 mm. Distance between node centres is about 0.33 mm and there are usually 3–4 nodes per 1 mm. Nodes are also present on branch reverse side. Dissepiments are 0.23–0.50 mm wide. Branches and dissepiments narrow towards reverse side of colony. There are normally 3 rows of zooecia on branches; 4 prior to and 2 after bifurcation. Fenestrules are 0.35–0.77 mm long and 0.22–0.56 mm wide. Zooecial apertures ovate; usually 0.18 x 0.13 mm; 16–20 per 5 mm. Distance between apertural centres is about

0.27 mm along branch, and 0.24 across branch. Zooecial apertures border and commonly open inwards into fenestrules and thus produce a rather irregular outline to the fenestrules. Autozooecial chambers are rectangular to hexagonal in middle row(s); pentagonal or more irregular in marginal rows. Chamber reverse wall budding angle 59–67° in longitudinal section.

Comparison.—P. borealis is distinguished from *P. visenda* Goryunova, 1975b in having larger and more widely spaced fenestrules, from *P. orientalis* (Eichwald, 1860) in having larger and more widely spaced zooecial apertures and closely-spaced branches, and from *P. subcrotilla* (Trizna, 1950) in having larger and more widely-spaced carinal nodes. *P. lyndoni* (Ross, 1963) from the Lower Permian of Australia has features in common with *P. borealis* but it has generally larger fenestrules and more widely spaced apertures.

Measurements.—See Table 31.

Material.—AKS-A-5.0m (PMO 132.104), AKS-A-6.0m (PMO 132.074), AKS-A-7.0m (PMO 118.061), AKS-A-8.0m (PMO 118.077), AKS-A-9.5m (PMO 118.066), FES-10-4.0m (PMO A42091, 118.088).

Stratigraphical distribution outside Spitsbergen.— P. borealis is recorded from the Artinskian (Komichan) of Timan (Nikiforova 1938), the Artinskian of the Urals and the Artinskian "Unnamed Formation" of Ellesmere Island (Morozova & Kruchinina 1986).

Genus POLYPORA M'Coy, 1844

Type species.—Polypora dendroides M'Coy, 1844, from the Lower Carboniferous of Ireland.

Polypora brevicellata Baranova, 1960
Plate 15, Figs. C, E.

1960b *Polypora brevicellata* Baranova, p. 264, pl. 66, fig. 1.

1975b *Polypora brevicellata* Baranova; Goryunova, p. 91, pl. 23, fig.1.

1986 *Polypora brevicellata* Baranova; Morozova & Kruchinina, p. 104, pl. 38, figs. 3a–d.

1992 *Polypora brevicellata* Baranova; Sakagami, pl. 6, fig. 4.

Description.—Polypora with large, elongated fenestrules and slender branches producing a relatively open meshwork. There are 4.5–6 branches per 10 mm across colony and most commonly 3–5 fenestrules per 10 mm along colony. Branches bearing 4 rows of apertures are 0.73–0.87 mm wide, and branches with 5–6 rows are 0.98–1.23 mm wide. Maximum branch thickness is about 1.0–1.2 mm. Branch surfaces are pierced by numerous small stylets. Dissepiments are commonly 0.45–0.70 mm wide. Fenestrule dimensions, especially fenestrule length show large intercolonial variation, whereas intracolonial variation is significantly smaller. Fenestrules are about 1.40–3.10 mm long and 1.00–1.20 wide. Apertures are distinctly ovate, measuring 0.17 x 0.13 mm. There are 4–6 rows of apertures on each branch, and 5–6 per fenestrule. Distance between apertural centres is 0.35–0.45 along and 0.24–0.30 diagonally across branch. Autozooecial chambers are rhomboid or less commonly hexagonal in median tangential section. Nodes are not observed on branch surfaces. Chamber reverse wall budding angle shows little variation (68–72°) in longitudinal section.

Comparison.—Zoarial dimensions in *P. brevicellata* are similar to several other Permian species of *Polypora* (see tabulated formulae below) with at least 40 matching micrometric formulae. The Spitsbergen specimens are, however, distinguished from the other early Permian species such as *P. sulaensis* Nikiforova, 1938, in the absence of large tubercles on branch surfaces, and from *P. medvedkensis* Shul'ga-Nesterenko, 1949, which has smaller apertures (0.09 mm diameter). *P. extenta* has more closely-spaced apertures.

Micrometric formulae as described for species resembling the Spitsbergen material:

P. brevicellata Baranova, 1960b: 5–7/3–4/13–16/5–7 (8–9, 4–5)

P. brevicellata Baranova, 1960b, *in* Morozova & Kruchinina (1986): 5–6/4/12–14/6 (7–8)

P. extenta Trizna, 1939: 4–5/3–4/12–14/5–7

P. extenta Trizna, 1939, *in* Morozova & Kruchinina (1986): 4/3–4/15/4–6 (8–9)

P. medvedkensis Shul'ga-Nesterenko, 1949: 5–7/3–4/13–14/4–6

P. sulaensis Nikiforova, 1938: 4–5/3–4/13–13/6

Measurements.—See Table 32.

Material.—AKS-A-11.8 (PMO 118.106/1–6), FES-10-15.0m (PMO A42088, 138.078, 138.079, 138.083/1–3).

Stratigraphical distribution outside Spitsbergen.—Sakmarian of the northern Urals (Baranova 1960b), Artinskian of Timan and the Malozemel'sk Tundra (Morozova & Kruchinina 1986).

Polypora martis Fischer de Waldheim, 1837
Plate 15, Figs. F–I; Plate 16, Figs. A, B.

1837 *Polypora martis* Fischer de Waldheim, p. 165, pl. 39, fig. 2.
1876 *Polypora martis* Fischer de Waldheim; Trautschold, p. 91, pl. 11, fig. 2.
1888 *Polypora martis* Fischer de Waldheim; Stuckenberg, p. 34, pl. 3, figs. 56–58, pl. 4, fig. 30.
1895 *Polypora martis* Fischer de Waldheim; Stuckenberg, p. 160.
1915 *Polypora martis* Fischer de Waldheim; Bolkhovitinova, p. 71, pl. 6, fig. 6.
1938 *Polypora martis* Fischer de Waldheim; Nikiforova, p. 241, pl. 25, figs. 1–9, pl. 26, figs. 1–7.
1951 *Polypora martis* Fischer de Waldheim; Shul'ga–Nesterenko, p. 134, pl. 1, fig. 8, pl. 30, figs. 3–4, text–fig. 53.
1955 *Polypora martis* Fischer de Waldheim; Morozova, p. 32.
1961 *Polypora martis* Fischer de Waldheim; Trizna, p. 82–85, text–figs. 31a–b.
1962 *Polypora* sp. cf. *martis* Fischer de Waldheim; Ross & Ross, p. 51, pl. 14, figs. 1, 5.
1975 *Polypora martis* Fischer de Waldheim; Goryunova & Kruchinina, p. 150, pl. 59, fig. 9.

Description.—Meshwork moderately compact with broad, thick branches and relatively small fenestrules. There are 7–10 branches per 10 mm across and 5–8 fenestrules per 10 mm along colony. The branches with 5–6 rows of apertures are 0.82–1.10 mm wide (with 3–4 rows; 0.55–0.73 mm wide) on obverse side, whereas they narrow progressively to 0.36–0.55 on reverse side. Branch thickness is maximum 1.14 mm measured in longitudinal section. Tubercles with star–like internal structure (Pl. 15, Fig. F), about 0.09 mm in diameter are irregularly distributed on the obverse side of branches. Interapertural areas are pierced with numerous stylets. The branches are strongly striated near reverse surface. Dissepiments are about 0.54 mm wide, being wider on obverse than on reverse colony surface. Fenestrules are relatively small and indented by apertures on obverse side of colony, commonly 0.55–0.80 × 0.36–0.46 mm, whereas they are significantly larger on reverse side (1.00–1.14 × 0.82–1.00 mm). Apertures are circular to slightly ovate, commonly 0.13–0.15 mm in diameter. Distance between apertural centres is 0.22–0.29 mm along and 0.21–0.26 across branch, with 17–20 apertures per 5 mm along branch. Apertures project into fenestrule openings. There are commonly 4–6 rows of apertures on the branches; 6 prior to bifurcation and 3 immediately after bifurcation. Autozooecial chambers are regularly hexagonal–shaped in mid–tangential section. Between normal chambers, there are occasionally irregularly shaped and larger chambers (Pl. 16, Fig. A). The latter chambers are considered to represent ovicells, as they resemble the features described as ovicells in *Reteporidra* (Morozova 1970a: p. 231) and *Kingopora* (Morozova & Kruchinina 1986: p. 115). Chamber reverse wall budding angle shows great variation (39–80°) in longitudinal section, possibly due to variation in section orientation.

Comparison.—*P. martis* belongs to a group of co–occurring Early Permian species of *Polypora* but is characterized by the presence of the many large tubercles on its branch surface. The Spitsbergen specimens have, however, slightly more closely spaced apertures as compared with other records (17–20 versus 15–16). Morphometrically similar records of this and other species from the Carboniferous and Lower Permian and their micrometric formula include:

P. martis Fischer de Waldheim, 1837 *in* Nikiforova 1938: 8–10/6–8/15–17/3–4

P. martis Fischer de Waldheim, 1837 *in* Trizna 1948: 8–10/7–8/15–16/3–4(5–2)

P. martis Fischer de Waldheim, 1837 *in* Shul'ga–Nesterenko 1949 and 1951: 9–10/6–8/15–16/4

P. martis Fischer de Waldheim, 1837 *in* Trizna 1961: 8–10/6–10/14–16/3–5

P. cf. *martis* Fischer de Waldheim, 1837 *in* Ross & Ross 1962: 8/6–7.5/17–18/4–6

P. nadinae Shul'ga–Nesterenko, 1952: 7–11/6/14–17/4(2–6)

P. prodigosa Trizna, 1948: 8–12/6/16–18/4(2–5)

Measurements.—See Table 33.

Material.—AKS–A–7.0m (PMO 118.055, 118.056), FES–10–4.0m (PMO 118.087).

Stratigraphical distribution outside Spitsbergen.— Early Permian of Timan (Nikiforova 1938), Late Carboniferous of eastern North Greenland (Mallemuk Mountain Group) (Ross & Ross 1962), Artinskian and Carboniferous of the Urals (Trizna 1948; Shul'ga-Nesterenko 1951).

Genus PROTORETEPORA de Koninck, 1876.

Type species.—*Fenestella ampla* Lonsdale, 1844, from the Carboniferous of N.S.W., Australia.

Protoretepora sp. A.
Plate 16, Figs. C–H.

Description.—Robust meshwork made up of wide branches with large nodes, short dissepiments and relatively small, narrow fenestrules. There are 7–8 branches per 10 mm across colony, and 4–5.5 fenestrules along colony per 10 mm. Branch width averages 1.13 mm; maximum 1.60 mm prior to bifurcation and 0.80 mm after bifurcation. Nodes, 0.09–0.14 mm in diameter, are randomly distributed on branches between apertures. Numerous stylets pierce zooecial walls producing a spotted surface. Dissepiments are very short and 0.70–0.90 mm wide. Fenestrules are 0.91–1.30 mm long and 0.32–0.59 mm wide, commonly indented by apertures opening into fenestrule. Apertures are relatively large, circular, 0.16–0.18 mm in diameter. Distance between centres of apertures is 0.27–0.40 mm along branch, and 0.18–0.24 across branch. There are about 16–17 apertures per 5 mm along branch. 6–7 rows of apertures are commonly developed, increasing to 9 prior to bifurcation, and decreasing to 4 immediately after bifurcation. Autozooecial chambers are irregularly pentagonal to hexagonal in median tangential section.

Remarks.—Only a tangential section was prepared, and reverse wall budding angle could not be measured. This specimen probably represents a new species which cannot be described until more material is at hand.

Comparison.—The current species, with micrometric formula 7–8/4–5.5/15.5–17.5/4–9, resembles some Early Permian taxa from Australia and Timan:

P. ampla (Lonsdale, 1844): 4–6/6–9/12–15/4–8
P. flexuosa Crockford, 1957: 6–7/4–5/12–15/5
P. komichensis (Kruchinina, 1973): 8.5–9/7/15–16/4–8.

Measurements.—See Table 34.

Material.—KWÆ-1–0.15m (PMO A42273).

Acknowledgements

Support from the following is greatly acknowledged: IKU Petroleum Research (Trondheim) "Arctic Geo-Program" (with funding oil companies A/S Norske Shell, BP Petroleum (Norway) Ltd., Elf Aquitaine Norge A/S, Esso Norge A/S, Fina Exploration Norway A/S, Mobil Exploration Norway Inc., Norsk Agip A/S, Norsk Hydro A/S, Phillips Petroleum Co. Norway, Saga Petroleum A/S, Statoil) and project manager A. Mørk. R. M. Konieczny (Festningen, Kapp Wijk, Kapp Wærn and Sveltihel sections), N.-M. Hanken and K.-R. Fredriksen (Akseløya section) are thanked for assistance and inspiring discussions in the field. The text was scientifically and grammatically improved thanks to valuable comments from E. H. Gilmour (Eastern Washington University, Cheney), S. J. Hageman (Appalachian State University, Boone), J. R. P. Ross (Western Washington University, Bellingham) and P. D. Taylor (The Natural History Museum, London) who reviewed the manuscript.

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Tables 1 - 16

Table 1. Summary statistics for *Cyclotrypa distincta* Morozova. (7 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	13.417	10.672	79.54	7.30	35.00	6
DIA/1	3.572	1.448	40.53	1.60	6.80	32
AL	0.261	0.046	17.48	0.20	0.35	33
AW	0.238	0.036	15.11	0.18	0.30	33
AAS	0.140	0.043	30.85	0.05	0.24	47
AAR	0.349	0.057	16.17	0.22	0.46	47
AAR/2	5.180	0.648	12.52	3.70	7.50	45
VES/1	9.089	1.588	17.47	5.90	11.50	44

Table 2. Summary statistics for *Cyclotrypa eximia* Morozova. (9 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	--	--	--	--	--	--
DIA/1	2.680	1.180	44.02	1.20	5.10	46
AL	0.316	0.063	20.00	0.19	0.41	70
AW	0.274	0.043	15.59	0.19	0.33	70
AAS	0.112	0.034	30.54	0.04	0.20	73
AAR	0.379	0.072	18.94	0.24	0.49	74
AAR/2	5.105	0.901	17.65	3.70	7.50	58
VES/1	7.298	1.771	24.27	4.40	12.00	51

Table 3. Summary statistics for *Meekopora magnusi* sp. nov. (4 specimens)

	AVG	STDS	CV	MIN	MAX	n
BT	10.183	2.903	28.50	7.20	15.00	6
AL	0.299	0.035	11.67	0.25	0.38	22
AW	0.290	0.053	18.29	0.24	0.40	22
AAL	0.417	0.049	11.87	0.32	0.50	16
AAL/2	4.550	0.331	7.28	3.90	5.00	18
AAC/2	5.228	0.717	13.71	4.00	6.60	18
LUNL	0.093	0.027	29.14	0.06	0.15	10
LUNW	0.166	0.013	7.62	0.15	0.18	10
EXWA	0.168	0.057	33.83	0.08	0.31	45
ENWA	--	--	--	--	--	--

Table 4. Summary statistics for *Tabulipora siedleckii* Małecki. (20 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	9.290	3.005	32.34	5.20	17.30	20
EW	2.294	1.128	49.16	1.10	5.00	22
DIA/1	2.444	0.701	28.69	1.00	3.80	34
AL	0.244	0.030	12.19	0.17	0.33	83
AW	0.195	0.024	12.52	0.15	0.29	83
AAR	0.280	0.028	10.09	0.22	0.33	60
AAL/2	5.838	0.752	12.89	4.40	8.00	74
AAC/2	6.272	0.873	13.92	4.40	8.20	78
EXIL	0.091	0.026	28.99	0.04	0.15	66
EXIL/A	1.528	1.502	98.32	0.00	5.00	36
MACA	0.132	0.024	18.32	0.08	0.18	101
MICA	0.022	0.005	24.34	0.02	0.04	20
MACA/A	3.235	1.232	38.09	0.00	6.00	34
MICA/A	18.167	5.060	27.85	10.00	30.00	12
EXWA	0.093	0.022	24.06	0.05	0.15	33
ENWA	0.018	0.015	83.14	0.01	0.06	20

Table 5. Summary statistics for *Tabulipora* sp. A. (5 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	24.125	12.029	49.86	13.00	45.00	8
EW	2.940	1.539	52.34	1.00	5.00	5
DIA/1	2.400	0.815	33.97	1.30	3.70	14
AL	0.263	0.018	6.85	0.24	0.32	40
AW	0.221	0.029	13.22	0.18	0.29	41
AAR	0.309	0.034	11.06	0.26	0.40	19
AAR/2	6.350	0.686	10.81	5.00	7.80	40
EXIL	0.092	0.024	26.16	0.05	0.14	30
EXIL/A	0.900	0.994	110.49	0.00	3.00	10
MACA	0.133	0.025	18.59	0.10	0.20	38
MICA	0.017	0.005	28.01	0.01	0.02	4
MACA/A	2.467	1.060	42.98	0.00	4.00	15
MICA/A	19.000	4.243	22.33	16.00	22.00	2
EXWA	0.058	0.019	32.13	0.04	0.11	12
ENWA	0.011	0.003	30.60	0.01	0.02	10

Table 6. Summary statistics for *Rhombotrypella alfredensis* Morozova. (9 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	5.157	1.326	25.71	3.60	7.50	14
EW	0.765	0.455	59.50	0.30	1.80	17
DIA/1	2.000	0.000	0.00	2.00	2.00	2
AL	0.216	0.030	13.78	0.16	0.27	59
AW	0.161	0.035	21.99	0.10	0.23	59
AAR	0.274	0.030	10.80	0.22	0.33	32
AAL/2	5.767	0.552	9.57	5.00	6.60	21
AAC/2	6.529	0.831	12.72	5.00	8.20	21
EXLL	0.064	0.022	33.75	0.03	0.11	24
EXLW	0.060	0.022	37.41	0.03	0.11	24
SQ/1	4.800	0.799	16.65	3.80	6.20	14
MACA	0.134	0.029	21.69	0.09	0.19	40
MICA	0.024	0.006	23.96	0.02	0.04	11
MACA/A	3.133	0.834	26.61	1.00	4.00	15
MICA/A	16.400	3.507	21.38	12.00	20.00	5
EXWA	0.121	0.046	38.24	0.08	0.27	21
ENWA	0.010	0.001	12.77	0.01	0.01	9

Table 7. Summary statistics for *Rhombotrypella arbuscula* (Eichwald). (7 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	2.378	0.645	27.11	1.60	3.70	30
EW	0.355	0.129	36.39	0.21	0.51	15
DIA/1	--	--	--	--	--	--
AL	0.215	0.048	22.57	0.18	0.25	22
AW	0.130	0.032	24.77	0.10	0.18	22
AAR	0.269	0.073	27.01	0.23	0.31	14
AAL/2	5.333	1.364	25.57	4.40	6.30	18
AAC/2	7.531	2.068	27.46	6.00	10.00	16
EXLL	0.066	0.025	37.62	0.04	0.09	12
EXLW	0.060	0.021	35.56	0.04	0.09	12
SQ/1	6.326	1.458	23.05	5.00	7.20	23
MACA	0.101	0.023	22.70	0.07	0.13	33
MICA	0.030	0.014	47.37	0.02	0.05	14
MACA/A	3.600	1.191	33.08	3.00	4.00	10
MICA/A	18.167	8.080	44.48	12.00	25.00	6
EXWA	0.094	0.033	34.81	0.07	0.11	9
ENWA	0.015	0.007	44.81	0.02	0.02	4

Table 8. Summary statistics for *Stenopora thula* Ross & Ross. (3 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	4.686	0.536	11.45	4.00	6.30	16
EW	1.009	0.132	13.04	0.70	1.20	13
AL	0.238	0.021	8.66	0.20	0.27	25
AW	0.188	0.018	9.77	0.15	0.22	25
AAR	0.321	0.046	14.37	0.27	·0.40	13
AAR/2	5.483	0.589	10.74	4.60	6.90	30
EXIL	0.082	0.029	34.98	0.05	0.15	35
EXIL/A	3.480	2.044	58.73	0.00	8.00	25
MACA	0.065	0.020	29.83	0.04	0.11	41
MACA/A	6.545	2.207	33.72	3.00	10.00	11
EXWA	0.100	0.031	30.77	0.06	0.16	19
ENWA	0.017	0.002	8.95	0.02	0.02	11

Table 9. Summary statistics for *Dyscritella bogatensis* Morozova. (2 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	10.475	0.411	3.93	10.00	11.00	4
EW	2.550	0.857	33.60	1.30	3.30	7
AL	0.241	0.038	15.65	0.17	0.29	18
AW	0.192	0.031	16.31	0.15	0.24	18
AAR	0.269	0.063	23.45	0.18	0.35	18
AAL/2	6.027	0.723	11.99	5.20	7.80	22
AAC/2	6.959	1.666	23.94	5.20	9.40	22
EXIL	0.100	0.032	31.58	0.06	0.15	11
EXIL/A	1.571	1.512	96.21	0.00	4.00	7
MACA	0.120	0.033	27.15	0.09	0.18	14
MACA/A	2.111	1.453	68.82	0.00	4.00	9
EXWA	0.063	0.014	22.48	0.05	0.10	14
ENWA	0.012	0.001	10.62	0.01	0.01	14

Table 10. Summary statistics for *Dyscritella minuta* Morozova. (15 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	1.841	0.294	15.96	1.30	2.32	33
EW	0.458	0.155	33.79	0.23	0.72	24
AL	0.209	0.014	6.49	0.18	0.24	41
AW	0.131	0.027	20.87	0.09	0.18	41
AAR	0.181	0.018	9.91	0.14	0.20	24
AAL/2	7.116	0.828	11.64	5.70	8.60	25
AAC/2	9.992	1.436	14.38	6.60	12.00	25
EXIL	0.043	0.012	27.99	0.03	0.08	27
EXIL/A	2.889	3.621	125.34	0.00	10.00	9
MACA	0.057	0.021	36.48	0.03	0.11	44
MACA/A	4.800	1.056	22.01	3.00	7.00	20
EXWA	0.064	0.020	31.28	0.04	0.10	17
ENWA	0.016	0.008	50.14	0.01	0.03	7

Table 11. Summary statistics for *Dyscritella* sp. A. (5 specimens)

	AVG	STDS	CV	MIN	MAX	n
BT	1.454	0.742	51.06	0.42	2.50	7
EW	--	--	--	--	--	--
AL	0.299	0.036	12.03	0.21	0.35	14
AW	0.291	0.031	10.75	0.21	0.34	14
AAR	0.389	0.029	7.42	0.35	0.44	10
AAR/2	5.133	0.459	8.95	4.40	6.00	15
EXIL	0.115	0.040	34.44	0.04	0.15	8
EXIL/A	--	--	--	--	--	--
MACA	0.080	0.026	33.10	0.05	0.13	15
MACA/A	3.000	--	--	3.00	3.00	1
EXWA	0.057	0.024	41.82	0.03	0.09	14
ENWA	0.014	0.004	30.50	0.01	0.02	11

Table 12. Summary statistics for *Clausotrypa monticola* (Eichwald). (10 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	1.012	0.150	14.78	0.77	1.36	21
EW	--	--	--	--	--	--
AL	0.195	0.037	19.14	0.15	0.27	15
AW	0.123	0.010	8.42	0.11	0.14	15
AAL	0.589	0.112	19.00	0.45	0.73	11
AAC	0.342	0.043	12.55	0.27	0.40	9
AAL/2	3.667	0.758	20.68	2.70	4.80	9
AAC/2	5.950	0.735	12.35	5.00	7.00	8
EXIL	0.036	0.003	9.62	0.03	0.04	4
ACA	0.038	0.008	20.88	0.03	0.06	16
EXWA	0.180	0.070	38.69	0.09	0.24	5
ENWA	0.020	0.002	8.43	0.02	0.02	9

Table 13. Summary statistics for *Streblascopora germana* (Bassler). (8 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	0.915	0.176	19.28	0.72	1.15	8
EW	0.334	0.069	20.59	0.27	0.43	5
AB	0.226	0.043	19.19	0.16	0.28	5
AL	0.183	0.015	8.12	0.16	0.22	20
AW	0.097	0.013	13.83	0.07	0.12	20
AAL	0.476	0.038	8.05	0.42	0.55	16
AAC	0.276	0.039	14.24	0.22	0.36	17
AAL/2	4.221	0.236	5.59	3.80	4.50	14
AAC/2	6.933	0.731	10.55	6.10	7.80	6
MET	0.032	0.006	18.00	0.03	0.05	11
MET/A	9.000	0.816	9.07	8.00	10.00	10

Table 14. Summary statistics for *Permoheloclema merum* Ozhgibesov. (8 specimens)

	AVG	STDS	CV	MIN	MAX	n
BD	0.719	0.168	23.37	0.55	1.15	17
EW	--	--	--	--	--	--
AL	0.129	0.016	12.75	0.11	0.15	8
AW	0.079	0.008	10.60	0.07	0.09	8
AAL	0.290	0.037	12.59	0.25	0.33	4
AAC	0.230	0.014	6.15	0.22	0.24	2
AAL/2	7.000	1.171	16.73	5.30	8.50	10
AAC/2	6.700	0.000	0.00	6.70	6.70	2
CAP	0.009	0.001	11.11	0.01	0.01	3
EXWA	0.160	0.028	17.68	0.14	0.18	2
ENWA	0.085	0.007	8.32	0.08	0.09	2

Table 15. Summary statistics for *Timanodictya nikiforovae* Morozova. (10 specimens)

	AVG	STDS	CV	MIN	MAX	n
BT	1.421	0.264	18.62	1.09	2.04	13
BW	2.348	0.424	18.04	1.81	2.73	6
AL	0.188	0.015	7.92	0.15	0.20	12
AW	0.168	0.011	6.62	0.15	0.18	12
LIN	0.014	0.005	32.78	0.01	0.02	6
AAL	0.474	0.025	5.34	0.44	0.52	15
AAC	0.327	0.024	7.44	0.29	0.37	15
AAL/2	4.040	0.114	2.82	3.90	4.20	5
AAC/2	6.140	0.416	6.77	5.60	6.70	5
CAP	0.018	0.001	3.48	0.02	0.02	10
EXWA	0.105	0.019	17.82	0.08	0.13	6
ENWA	0.021	0.002	9.23	0.02	0.02	7
MEDLA	0.020	0.002	11.08	0.02	0.02	8

Table 16. Summary statistics for *Girtyporina* sp. (4 specimens)

	AVG	STDS	CV	MIN	MAX	n
AL	0.207	0.007	3.15	0.20	0.22	12
AW	0.202	0.006	2.86	0.19	0.21	12
LIN	0.017	0.001	6.66	0.02	0.02	3
AAR	0.286	0.019	6.75	0.25	0.31	12
AAR/2	6.083	0.603	9.91	4.90	7.10	12
FOSS	0.108	0.006	5.86	0.10	0.12	10
EXWA	0.097	0.037	38.63	0.06	0.13	3
ENWA	--	--	--	--	--	--

Table 17. Summary statistics for *Fenestella akselensis* sp. nov. (4 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	18.917	1.928	10.19	15.20	21.40	29
DS10	14.336	0.863	6.02	12.70	16.60	28
A5	19.948	1.340	6.72	17.60	23.00	31
AFEN	3.250	0.500	15.38	3.00	4.00	4
WB	0.341	0.027	7.86	0.29	0.39	21
WD	0.282	0.035	12.54	0.23	0.35	19
FL	0.398	0.026	6.50	0.36	0.46	12
FW	0.233	0.026	11.17	0.19	0.27	12
AD	0.119	0.007	5.82	0.11	0.13	7
AAL	0.237	0.023	9.76	0.18	0.28	19
AAC	0.237	0.027	11.41	0.18	0.30	18
N1	3.667	0.308	8.39	3.30	4.00	6
SNB	0.266	0.027	10.24	0.22	0.31	18
NL	0.101	0.030	29.93	0.05	0.15	12
NW	0.061	0.018	30.43	0.04	0.10	12
RA	59.116	15.147	25.62	35.00	88.00	43

Table 18. Summary statistics for *Fenestella reversicnotta* sp. nov. (6 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	20.019	1.494	7.46	15.70	23.40	36
DS10	16.963	0.801	4.72	15.70	19.60	38
A5	23.259	1.839	7.91	19.20	27.00	34
AFEN	3.111	0.601	19.32	2.00	4.00	9
WB	0.364	0.101	27.81	0.23	0.60	28
WD	0.248	0.036	14.43	0.17	0.30	14
FL	0.399	0.061	15.31	0.32	0.51	12
FW	0.218	0.046	21.02	0.18	0.30	12
AD	0.125	0.016	12.84	0.10	0.15	14
AAL	0.225	0.018	7.97	0.20	0.28	32
AAC	0.217	0.022	9.99	0.16	0.26	31
N1	3.989	0.535	13.41	3.00	5.00	9
SNB	0.239	0.035	14.62	0.18	0.33	39
NL	0.106	0.032	29.84	0.07	0.18	18
NW	0.056	0.017	29.43	0.04	0.09	18
RA	55.947	3.880	6.93	48.00	63.00	19

Table 19. Summary statistics for *Fabifenestella* sp. B. (1 specimen)

	AVG	STDS	CV	MIN	MAX	n
BR10	7.629	1.144	15.00	5.30	8.90	7
DS10	5.250	0.794	15.13	4.60	6.50	6
A5	14.620	0.944	6.46	12.50	15.50	10
AFEN	6.500	0.707	10.88	6.00	7.00	2
WB	0.500	0.050	10.00	0.45	0.55	3
WD	0.390	0.014	3.63	0.38	0.40	2
FL	1.446	0.335	23.19	1.00	1.77	5
FW	0.740	0.078	10.60	0.64	0.86	5
AD	0.145	0.007	4.88	0.14	0.15	2
AAL	0.326	0.017	5.15	0.31	0.36	12
AAC	0.374	0.060	16.00	0.29	0.46	10
N1	2.600	--	--	2.60	2.60	1
SNB	0.380	--	--	0.38	0.38	1
NL	--	--	--	--	--	--
NW	--	--	--	--	--	--
RA	--	--	--	--	--	--

Table 20. Summary statistics for *Rectifenestella microporata* (Shul'ga-Nesterenko). (9 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	23.519	2.267	9.64	19.30	28.00	58
DS10	20.441	1.440	7.04	17.70	23.10	61
A5	23.853	2.596	10.88	19.40	30.00	45
AFEN	2.536	0.414	16.34	2.00	3.00	14
WB	0.238	0.034	14.44	0.18	0.30	24
WD	0.228	0.102	44.66	0.08	0.38	26
FL	0.293	0.075	25.46	0.16	0.46	25
FW	0.184	0.048	25.88	0.11	0.27	25
AD	0.108	0.017	15.97	0.08	0.14	16
AAL	0.200	0.021	10.63	0.16	0.24	39
AAC	0.224	0.017	7.48	0.20	0.26	35
N1	4.542	0.612	13.48	3.80	6.00	24
SNB	0.215	0.028	12.92	0.16	0.28	55
NL	0.071	0.022	31.15	0.04	0.11	30
NW	0.050	0.012	24.47	0.03	0.07	28
RA	69.308	7.662	11.05	52.00	85.00	26

Table 21. Summary statistics for *Rectifenestella retiformis* (Schlotheim). (2 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	19.350	0.404	2.09	18.70	20.00	8
DS10	16.411	0.699	4.26	15.20	17.50	9
A5	18.789	3.180	16.92	15.70	23.20	9
AFEN	2.750	0.289	10.50	2.50	3.00	4
WB	0.271	0.061	22.51	0.20	0.36	10
WD	0.158	0.033	21.12	0.12	0.24	11
FL	0.427	0.029	6.85	0.38	0.47	13
FW	0.275	0.032	11.73	0.18	0.30	13
AD	0.093	0.006	6.19	0.09	0.10	3
AAL	0.208	0.050	24.18	0.11	0.24	6
AAC	0.254	0.031	12.32	0.24	0.31	5
N1	4.033	0.058	1.43	4.00	4.10	3
SNB	0.245	0.008	3.41	0.23	0.25	6
NL	0.120	0.052	43.30	0.09	0.18	3
NW	0.080	0.010	12.50	0.07	0.09	3
RA	65.083	3.288	5.05	61.00	71.00	12

Table 22. Summary statistics for *Rectifenestella* sp. A. (3 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	19.531	1.680	8.60	18.00	23.20	16
DS10	14.960	0.825	5.52	13.80	16.70	15
A5	26.690	2.101	7.87	23.50	30.40	20
AFEN	3.700	0.274	7.40	3.50	4.00	5
WB	0.290	0.021	7.28	0.25	0.33	14
WD	0.180	0.023	12.77	0.15	0.22	15
FL	0.458	0.059	12.96	0.38	0.55	9
FW	0.256	0.024	9.28	0.22	0.31	11
AD	0.117	0.012	10.50	0.10	0.13	9
AAL	0.195	0.023	11.90	0.16	0.22	10
AAC	0.184	0.042	22.78	0.12	0.22	7
N1	4.317	0.431	9.98	3.90	5.00	6
SNB	0.221	0.024	10.93	0.20	0.25	7
NL	0.111	0.013	11.73	0.09	0.13	6
NW	0.057	0.011	19.03	0.05	0.07	6
RA	60.000	7.071	11.79	55.00	65.00	2

Table 23. Summary statistics for *Rectifenestella* sp. B. (2 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	12.491	0.362	2.90	12.00	13.20	11
DS10	8.109	0.318	3.92	7.80	8.80	11
A5	22.073	0.892	4.04	21.00	24.00	11
AFEN	5.500	0.577	10.50	5.00	6.00	4
WB	0.280	0.044	15.84	0.24	0.36	7
WD	0.182	0.035	19.20	0.16	0.25	6
FL	1.069	0.043	3.98	1.00	1.14	8
FW	0.585	0.037	6.33	0.55	0.66	8
AD	0.097	0.006	5.97	0.09	0.10	3
AAL	0.217	0.006	2.66	0.21	0.22	3
AAC	0.210	0.010	4.76	0.20	0.22	3
N1	4.000	--	--	4.00	4.00	1
SNB	0.245	0.035	14.43	0.22	0.27	2
NL	0.085	0.007	8.32	0.08	0.09	2
NW	0.006	0.001	23.57	0.01	0.01	2
RA	--	--	--	--	--	--

Table 24. Summary statistics for *Alternifenestella bifida* (Eichwald). (1 specimen)

	AVG	STDS	CV	MIN	MAX	n
BR10	12.700	0.141	1.11	12.50	12.80	4
DS10	9.720	0.228	2.35	9.50	10.10	5
A5	16.017	0.360	2.25	15.60	16.50	6
AFEN	3.500	0.707	20.20	3.00	4.00	2
WB	0.365	0.021	5.81	0.35	0.38	2
WD	0.175	0.019	10.94	0.16	0.20	4
FL	0.860	0.036	4.19	0.82	0.89	3
FW	0.443	0.025	5.68	0.42	0.47	3
AD	0.115	0.007	6.15	0.11	0.12	2
AAL	0.304	0.008	2.59	0.29	0.31	7
AAC	0.273	0.005	1.83	0.27	0.28	4
N1	1.750	0.071	4.04	1.70	1.80	2
SNB	0.582	0.032	5.48	0.53	0.62	6
NL	0.130	0.028	21.76	0.11	0.15	2
NW	0.100	0.014	14.14	0.09	0.11	2
RA	--	--	--	--	--	--

Table 25. Summary statistics for *Alternifenestella* cf. *greenharbourensis* (Nikiforova). (3 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	14.664	0.894	6.10	13.20	15.80	14
DS10	10.625	0.630	5.93	9.50	11.70	16
A5	18.582	0.199	1.07	18.30	18.90	11
AFEN	3.833	0.289	7.53	3.50	4.00	3
WB	0.315	0.035	11.15	0.28	0.35	4
WD	0.196	0.026	13.30	0.16	0.22	5
FL	0.782	0.053	6.76	0.73	0.90	10
FW	0.435	0.049	11.38	0.38	0.54	10
AD	--	--	--	--	--	--
AAL	--	--	--	--	--	--
AAC	--	--	--	--	--	--
N1	--	--	--	--	--	--
SNB	--	--	--	--	--	--
NL	--	--	--	--	--	--
NW	--	--	--	--	--	--
RA	--	--	--	--	--	--

Table 26. Summary statistics for *Alternifenestella* cf. *minuscula* Morozova. (1 specimen)

	AVG	STDS	CV	MIN	MAX	n
BR10	22.650	2.484	10.97	20.40	26.20	4
DS10	15.943	0.479	3.01	15.70	17.00	7
A5	16.889	0.605	3.58	15.90	18.00	9
AFEN	2.000	--	--	2.00	2.00	1
WB	0.300	0.014	4.71	0.29	0.31	2
WD	0.155	0.035	22.81	0.13	0.18	2
FL	0.368	0.022	6.03	0.35	0.40	4
FW	0.218	0.021	9.48	0.20	0.24	4
AD	0.093	0.005	5.41	0.09	0.10	4
AAL	0.290	0.021	7.23	0.25	0.31	6
AAC	0.275	0.008	3.04	0.27	0.29	6
N1	--	--	--	--	--	--
SNB	--	--	--	--	--	--
NL	--	--	--	--	--	--
NW	--	--	--	--	--	--
RA	--	--	--	--	--	--

Table 27. Summary statistics for *Alternifenestella subquadratopora* (Shul'ga-Nesterenko). (2 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	18.083	0.495	2.74	17.10	18.90	12
DS10	18.300	0.442	2.42	17.70	18.90	10
A5	18.542	0.320	1.73	18.10	19.10	12
AFEN	2.250	0.354	15.71	2.00	2.50	2
WB	0.310	0.013	4.16	0.29	0.33	7
WD	0.109	0.011	9.85	0.09	0.12	7
FL	0.447	0.014	3.17	0.42	0.46	9
FW	0.271	0.014	5.00	0.25	0.29	8
AD	0.125	0.007	5.66	0.12	0.13	2
AAL	0.279	0.009	3.14	0.27	0.29	10
AAC	0.258	0.008	3.06	0.25	0.27	10
N1	3.600	0.163	4.54	3.40	3.80	7
SNB	0.266	0.014	5.26	0.25	0.29	7
NL	0.103	0.010	9.34	0.09	0.11	4
NW	0.070	0.008	11.66	0.06	0.08	4
RA	--	--	--	--	--	--

Table 28. Summary statistics for *Alternifenestella* sp. A. (2 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	8.567	0.404	4.72	8.10	8.80	3
DS10	5.317	0.194	3.65	5.10	5.60	6
A5	16.364	1.057	6.46	15.00	17.70	11
AFEN	5.750	0.500	8.70	5.00	6.00	4
WB	0.513	0.142	27.66	0.38	0.64	4
WD	0.300	0.082	27.22	0.22	0.38	4
FL	1.385	0.035	2.55	1.36	1.41	2
FW	0.720	0.057	7.86	0.68	0.76	2
AD	0.153	0.015	9.84	0.14	0.17	4
AAL	0.282	0.008	2.97	0.27	0.29	5
AAC	0.324	0.015	4.68	0.30	0.34	5
N1	1.333	0.289	21.65	1.00	1.50	3
SNB	0.730	0.070	9.59	0.65	0.78	3
NL	0.220	--	--	0.22	0.22	1
NW	0.160	--	--	0.16	0.16	1
RA	--	--	--	--	--	--

Table 29. Summary statistics for *Lyropora serissima* sp. nov. (4 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	27.020	1.803	6.67	23.40	29.00	30
DS10	22.373	1.112	4.97	20.00	24.60	30
A5	26.977	2.256	8.36	22.90	30.50	30
AFEN	2.714	0.267	9.85	2.50	3.00	7
WB	0.242	0.070	28.87	0.16	0.42	20
WD	0.218	0.057	26.14	0.15	0.30	6
FL	0.255	0.065	25.63	0.18	0.33	6
FW	0.162	0.016	9.91	0.14	0.18	6
AD	0.096	0.007	7.60	0.09	0.11	9
AAL	0.183	0.027	14.85	0.15	0.26	33
AAC	0.214	0.020	9.21	0.16	0.25	34
N1	4.764	0.539	11.31	3.70	5.60	22
SNB	0.216	0.026	11.83	0.18	0.27	32
NL	0.113	0.036	31.84	0.09	0.25	21
NW	0.073	0.023	30.90	0.04	0.13	21
RA	70.000	3.347	4.78	66.00	75.00	6

Table 30. Summary statistics for *Polyporella biarmica* (Keyserling). (1 specimen)

	AVG	STDS	CV	MIN	MAX	n
BR10	9.260	0.699	7.54	8.50	10.00	5
DS10	7.520	0.179	2.38	7.30	7.80	5
A5	17.617	0.739	4.19	16.70	18.30	6
AROW	3.000	1.000	33.33	2.00	4.00	3
WB	0.586	0.118	20.21	0.41	0.73	5
WD	0.318	0.049	15.31	0.27	0.39	6
FL	1.057	0.055	5.24	1.00	1.14	6
FW	0.443	0.104	23.38	0.32	0.55	6
AD	0.145	0.049	34.14	0.11	0.18	2
AAL	0.243	0.008	3.36	0.23	0.25	6
AAC	0.262	0.010	3.76	0.25	0.27	6
N1	3.239	0.296	9.12	3.03	3.45	2
SNB	0.310	0.016	5.10	0.29	0.33	5
NL	0.066	0.008	12.43	0.06	0.07	5
NW	0.066	0.008	12.43	0.06	0.07	5
RA	--	--	--	--	--	--

Table 31. Summary statistics for *Polyporella borealis* (Stuckenberg). (7 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	13.633	1.632	11.97	9.70	16.30	24
DS10	11.025	0.505	4.58	10.10	11.80	24
A5	18.023	0.997	5.53	15.70	20.00	31
AROW	3.077	0.760	24.69	2.00	4.00	13
WB	0.524	0.140	26.82	0.31	0.80	21
WD	0.357	0.072	20.20	0.23	0.50	18
FL	0.537	0.140	26.01	0.35	0.77	14
FW	0.322	0.093	28.82	0.22	0.56	14
AD	0.149	0.018	12.34	0.13	0.18	17
AAL	0.274	0.028	10.36	0.22	0.33	42
AAC	0.242	0.029	12.01	0.18	0.33	51
N1	3.075	0.556	18.09	2.20	4.00	12
SNB	0.334	0.065	19.57	0.22	0.47	40
NL	0.124	0.039	31.16	0.06	0.22	37
NW	0.087	0.020	23.40	0.05	0.13	37
RA	63.500	2.593	4.08	59.00	67.00	10

Table 32. Summary statistics for *Polypora brevicellata* Baranova. (4 specimens)

	AVG	STDS	CV	MIN	MAX	n
BR10	5.179	0.618	11.93	4.40	6.30	19
DS10	3.913	1.115	28.50	2.20	5.20	23
A5	12.333	1.020	8.27	10.20	14.70	18
AROW	4.455	0.820	18.41	3.00	6.00	11
WB	0.955	0.133	13.97	0.73	1.23	15
WD	0.583	0.147	25.23	0.32	0.86	16
FL	2.122	0.954	44.96	1.37	3.64	13
FW	1.087	0.118	10.88	0.96	1.37	13
AD	0.144	0.016	10.91	0.12	0.17	11
AAL	0.402	0.043	10.71	0.29	0.46	17
AAC	0.265	0.026	9.80	0.22	0.31	17
N1	--	--	--	--	--	--
SNB	--	--	--	--	--	--
NL	--	--	--	--	--	--
NW	--	--	--	--	--	--
RA	69.600	1.817	2.61	68.00	72.00	5

Table 33. Summary statistics for *Polypora martis* Fischer de Waldheim. (2 specimens.

	AVG	STDS	CV	MIN	MAX	n
BR10	8.372	1.041	12.43	7.00	10.70	28
DS10	6.928	0.783	11.31	5.20	8.40	31
A5	18.320	0.814	4.44	16.70	20.00	29
AROW	4.667	1.000	21.43	3.00	6.00	9
WB	0.819	0.213	25.98	0.36	1.10	16
WD	0.544	0.139	25.49	0.41	0.86	9
FL	0.886	0.189	21.36	0.55	1.18	18
FW	0.657	0.257	39.15	0.36	1.10	18
AD	0.143	0.009	6.43	0.13	0.16	10
AAL	0.251	0.022	8.72	0.22	0.29	15
AAC	0.239	0.017	7.23	0.21	0.26	15
N1	--	--	--	--	--	--
SNB	--	--	--	--	--	--
NL	0.090	0.025	27.39	0.06	0.13	9
NW	0.086	0.020	23.00	0.06	0.13	9
RA	57.680	8.241	14.29	39.00	80.00	25

Table 34. Summary statistics for *Protoretepora* sp. A. (1 specimen)

	AVG	STDS	CV	MIN	MAX	n
BR10	7.340	0.369	5.02	6.90	8.00	10
DS10	4.810	0.433	9.01	4.10	5.40	10
A5	16.573	0.637	3.85	15.40	17.40	11
AFEN	7.000	--	--	7.00	7.00	1
AROW	6.625	1.768	26.68	4.00	9.00	8
WB	1.127	0.272	24.17	0.80	1.60	7
WD	0.775	0.104	13.39	0.68	0.90	4
FL	1.118	0.135	12.12	0.91	1.30	10
FW	0.405	0.087	21.44	0.32	0.59	10
AD	0.170	0.010	5.88	0.16	0.18	3
AAL	0.350	0.044	12.59	0.27	0.40	8
AAC	0.214	0.018	8.27	0.18	0.24	8
N1	--	--	--	--	--	--
SNB	--	--	--	--	--	--
NL	0.110	0.021	19.07	0.09	0.14	6
NW	0.110	0.021	19.07	0.09	0.14	6
RA	--	--	--	--	--	--

Plates 1 – 16

Photomicrographs are all from acetate peels except where noted.

Plate 1

A, B, D, E, F	*Cyclotrypa distincta* Morozova
A	Transverse section, AKS–A–8.0m, PMO A42649/4, x5, petrographic thin section
B	Shallow tangential section, AKS–A–7.0m, PMO 118.075/2, x25.
D	Deeper tangential section, AKS–A–8.0m, PMO A42649/5, x25, petrographic thin section.
E	Longitudinal section of specimen with crushed endozone, AKS–AKS–A–8.0m, PMO A42654/2, x10, petrographic thin section
F	Transverse section, AKS–A–7.0m, PMO 42650/3, x10, petrographic thin section
C, G, H	*Cyclotrypa eximia* Morozova
C	Rock specimen of brachiopod with encrusting layer of *C. eximia*, AKS–A–3.0m, PMO 118.081, x1
G	Tangential section with cross sections of bubble-like cystiphragms (arrow), FES–10–3.0m, PMO A42284, x25, petrographic thin section
H	Shallow tangential section, AKS–A–3.0m, PMO 118.081/1, x25

Plate 1

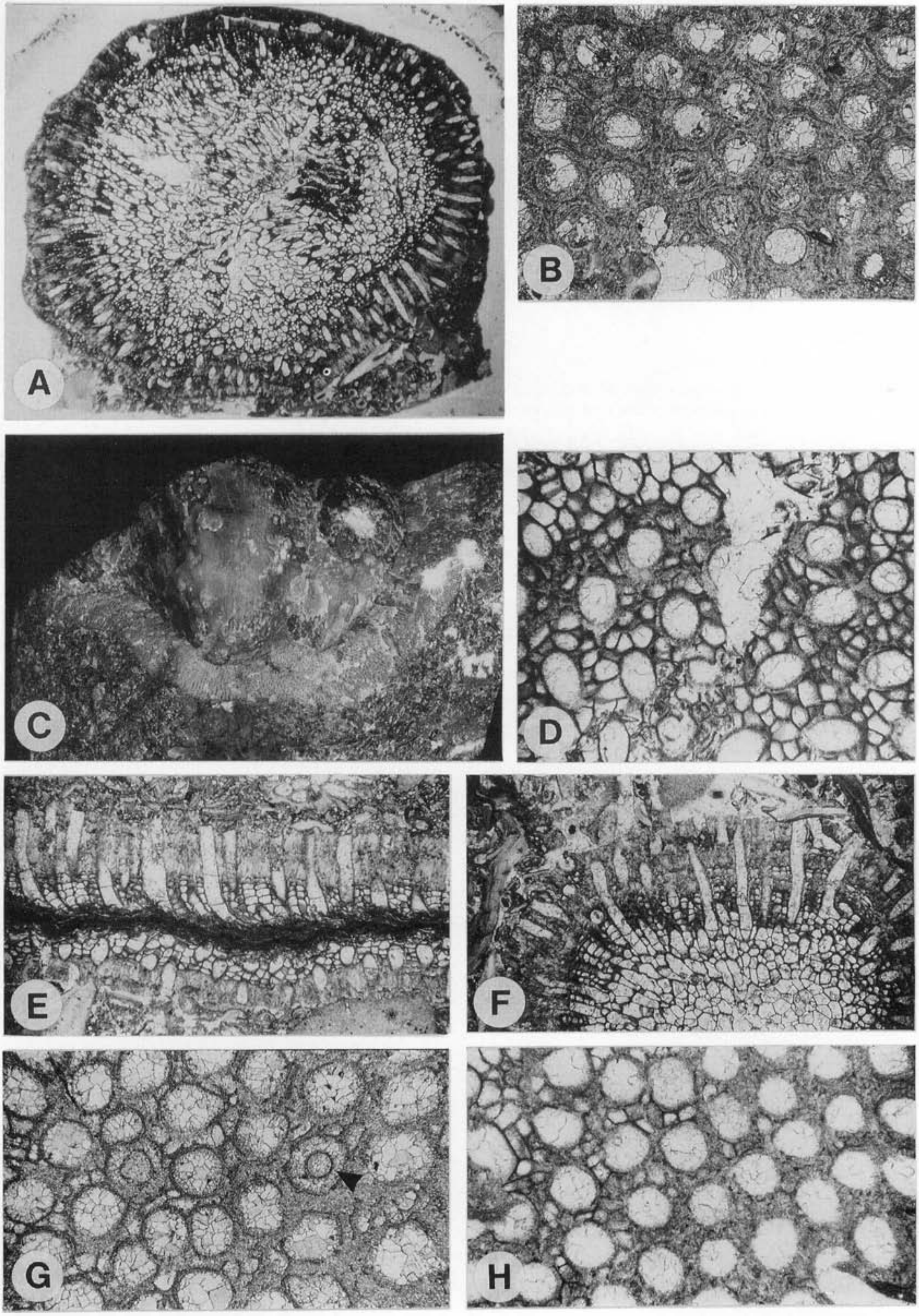

Plate 2

A–E	*Cyclotrypa eximia* Morozova
A	Longitudinal section of specimen attached to brachiopod shell, AKS–A–3.0m, PMO 118.081/8, x10
B	Tangential section of maculum, FES–10–3.0m, PMO A42284, x10, petrographic thin section
C	Transverse section of colony portion encrusting a bored brachiopod spine, AKS–A–3.0m, PMO 118.081/4A, x10
D	Larger portion of longitudinal section showing area with concentration of vesicular tissue, AKS–A–3.0m, PMO 118.081/3A, x4
E	Encrusting layer of *C. eximia* on *Tabulipora*, FES–10–1.0m, PMO A42218, x25, petrographic thin section
F, H	*Ramipora* cf. *hochstetteri* Toula
F	Transverse sections, FES–10–14.0m, PMO A42067, x10, petrographic thin section
H	Oblique longitudinal section close to point of bifurcation, FES–10–15.0m, PMO 138.085/2, x10
G	*Goniocladia* sp., deep tangential section of one fenestrule, AKS–A–11.8m, PMO 118.104, x10

Plate 2

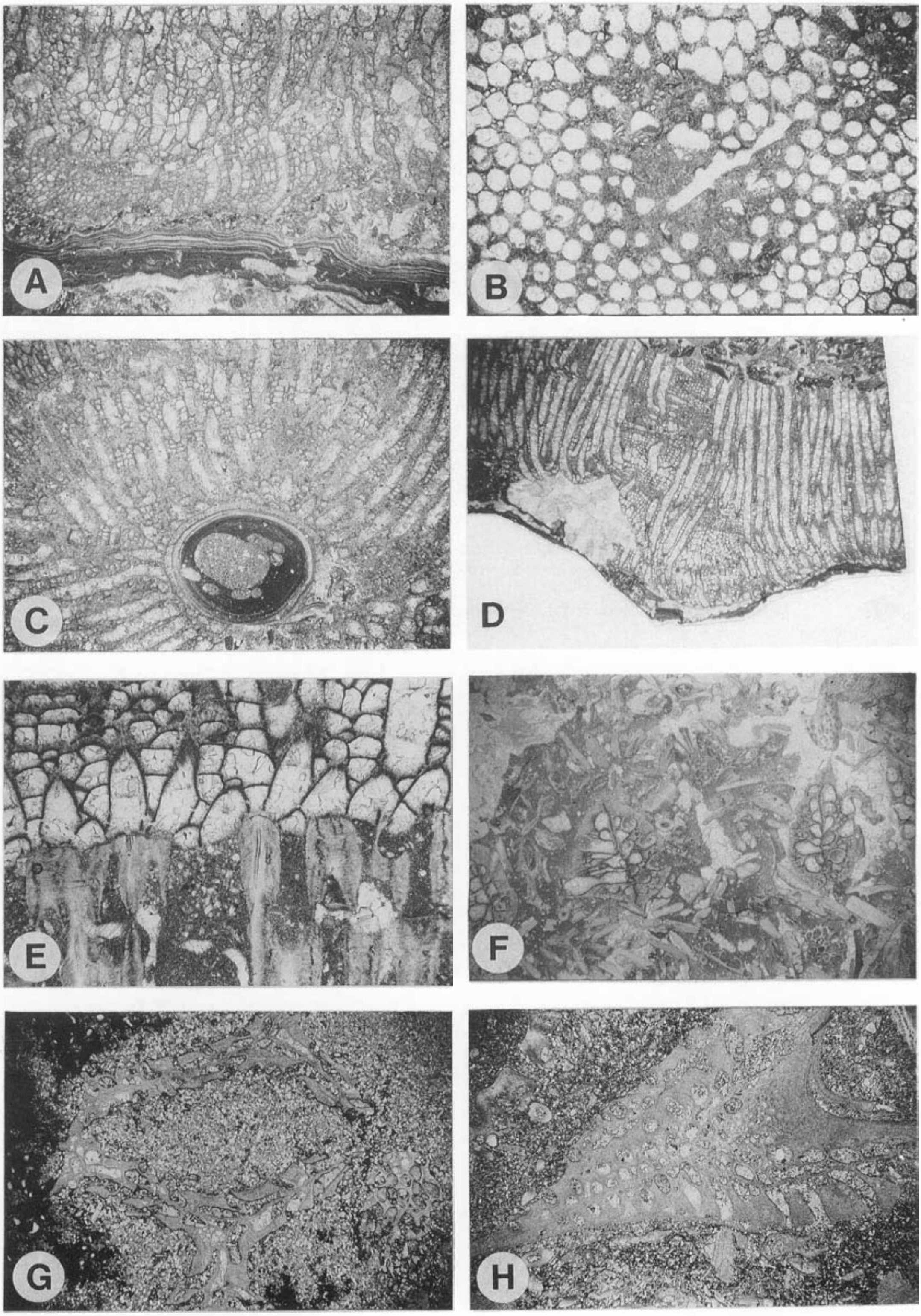

Plate 3

A–E	*Meekopora magnusi* sp. nov.
A	Polished rock specimen, AKS–A–5.0m, PMO 118.074, paratype, x2
B	Longitudinal section, KWÆ–1–2.0m, A42156/1, holotype, x4, petrographic thin section
C	Tangential section, KWÆ–1–2.0m, A42156/2, holotype, x25, petrographic thin section
D	Longitudinal section, KWÆ–1–2.0m, A42156/1, holotype, x25, petrographic thin section
E	Tangential section, KWÆ–1–2.0m, A42156/2, holotype, x10, petrographic thin section
F–H	*Tabulipora* sp. A.
F	Longitudinal section, KWÆ–1–0.01m, A42267, x25, petrographic thin section
G	Rock specimen showing internal structures with parallel endozonal tubes, SVH–basis, PMO 118.086, x2
H	Longitudinal section, KWÆ–1–0.01m, A42267, x10, petrographic thin section

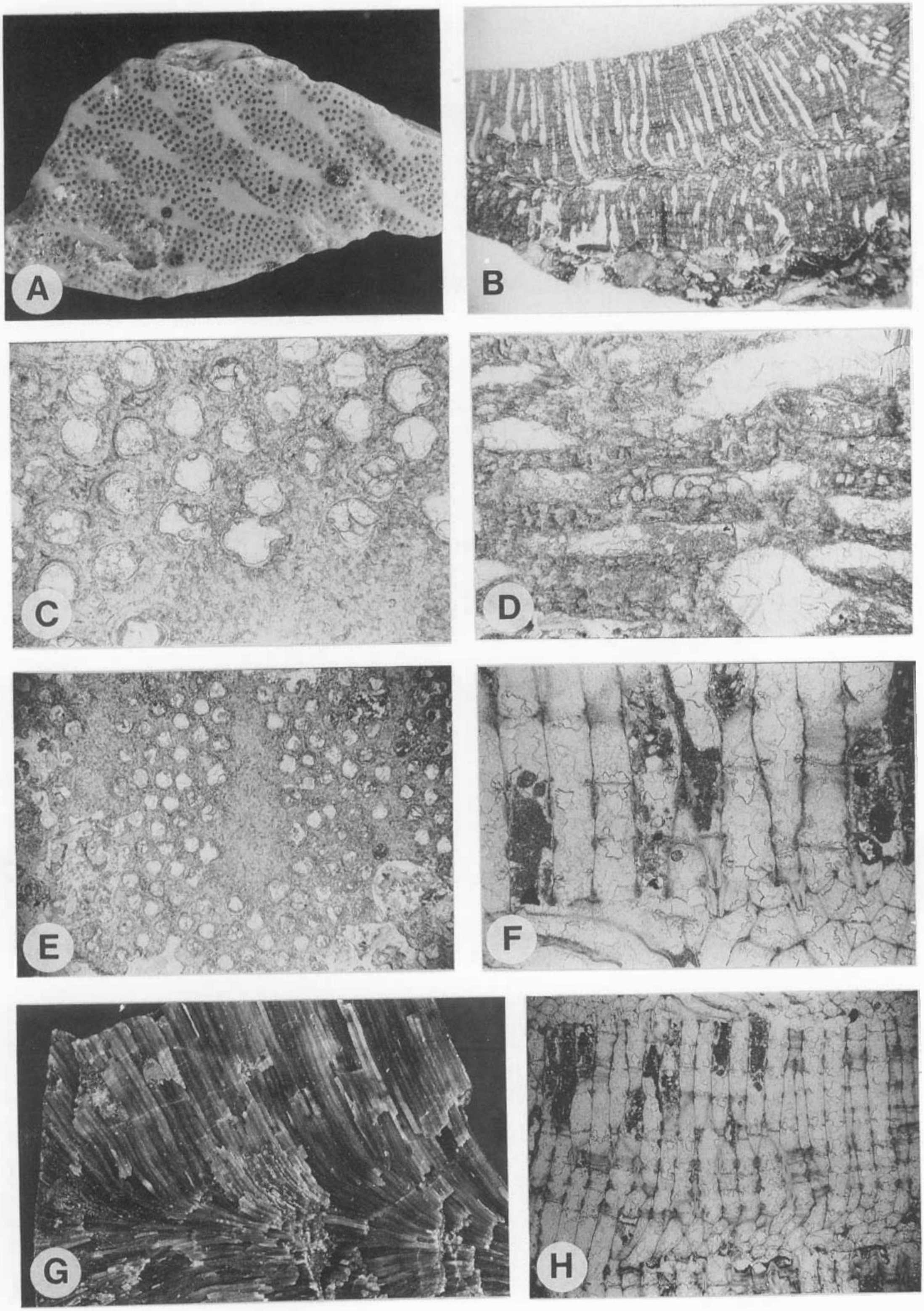
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Plate 4

A, B	*Tabulipora* sp. A.
A	Shallow tangential section, KWÆ–1–0.01m, PMO A42269, x25, petrographic thin section
B	Deeper tangential section, KWÆ–1–0.01m, PMO A42269, x25, petrographic thin section
C–H	*Tabulipora siedleckii* Małecki
C	Rock specimen with slightly silicified *T. siedleckii* in a shale/chert matrix, AKS–A–11.8m, PMO 138.128, x2
D	Tangential section, SVH–2–25.0m, PMO 118.082/1, x25
E	Transverse section, AKS–A–9.0m, PMO A42671/B, x4
F	Transverse section, AKS–A–9.0m, PMO A42671/A, x10
G	Longitudinal section with regenerated growth (arrows), SVH–2–25.0m, PMO 118.082/2, x25
H	Longitudinal section showing abundant perforated and complete diaphragms, SVH–2–25.0m, PMO 118.082/3, x25

Plate 4

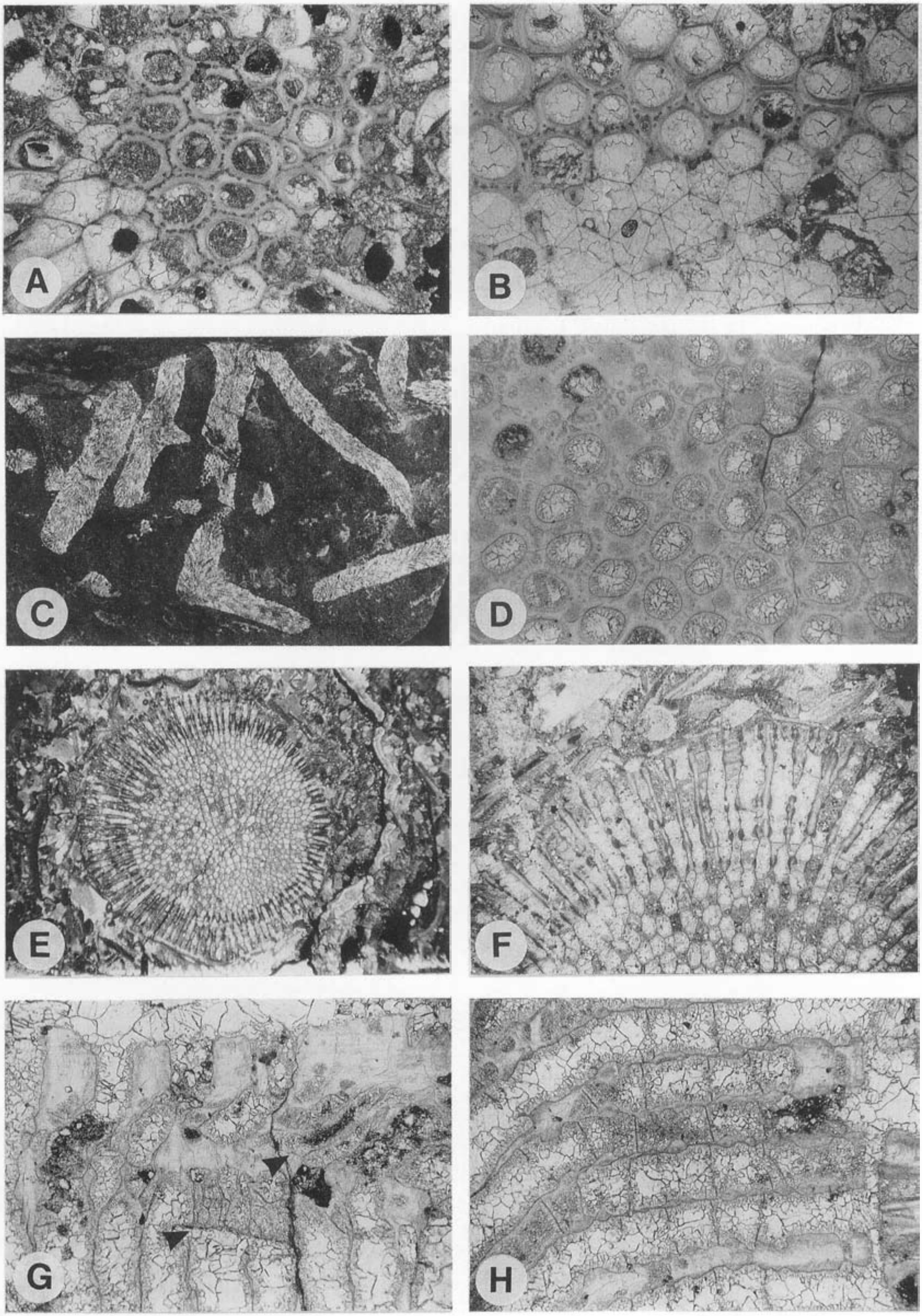

Plate 5

A, C, E, G	*Rhombotrypella alfredensis* Morozova
A	Tangential section, AKS–A–5.4m, PMO A42144/B, x25
C	Transverse section, AKS–A–3.0m, PMO 118.111/4, x10
E	Longitudinal section, exozone with terminal diaphragms closing off some zooecial tubes, AKS–A–3.0m, PMO 118.111/2B, x25
G	Intrazoarial overgrowth, AKS–A–3.0m, PMO 118.111/1B, x25
B, D, F, H	*Rhombotrypella arbuscula* (Eichwald)
	Tangential section, FES–10.15.0m, PMO A42278, x25, petrographic thin section
	Transverse section, FES–10–15.0m, PMO A42280, x25, petrographic thin section
	Longitudinal section with hook-like hemiphragms in exozone (arrow), FES–10–15.0m, PMO A42279, x25, petrographic thin section
H	Longitudinal section through portion of colony with regenerated growth perpendicular to original growth direction. AKS–A–11.8, PMO 118.103/5, x10

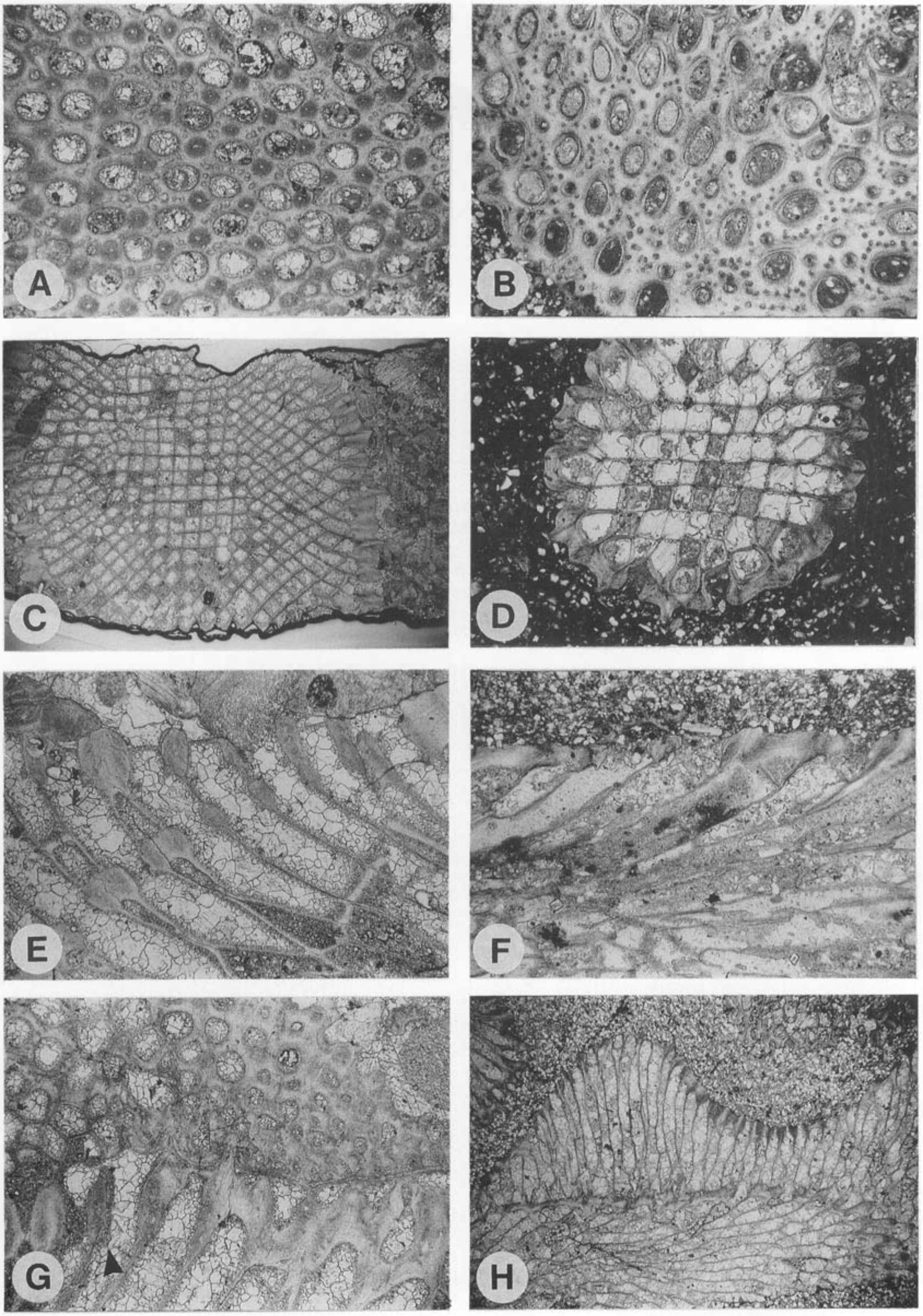
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Plate 6

A–C	*Stenopora thula* Ross & Ross
A	Transverse section of exozone, FES-10–15.0m, PMO 138.097, x25
B	Longitudinal section of exozone, FES-10–15.0m, PMO A42084/B, x25, petrographic thin section
C	Tangential section, FES-10–15.0m, PMO A42084/D, x25, petrographic thin section
D–F	*Dyscritella bogatensis* Morozova
D	Tangential section, AKS-A-9.0m, PMO A42668/B, x25, petrographic thin section
E	Transverse section, AKS-A-9.0m, PMO A42668/A, x10, petrographic thin section
F	Transverse section of outer exozone showing protruding acanthostyles, AKS-A-9.0m, PMO A42668/C, x25, petrographic thin section
G, H	*Dyscritella minuta* Morozova
G	Transverse section with well developed acanthostyles protruding into surrounding matrix, FES-10–15.0m, PMO 138.086, x25
H	Transverse section, AKS-A-1.3m, PMO A42660/2, x25

Plate 6

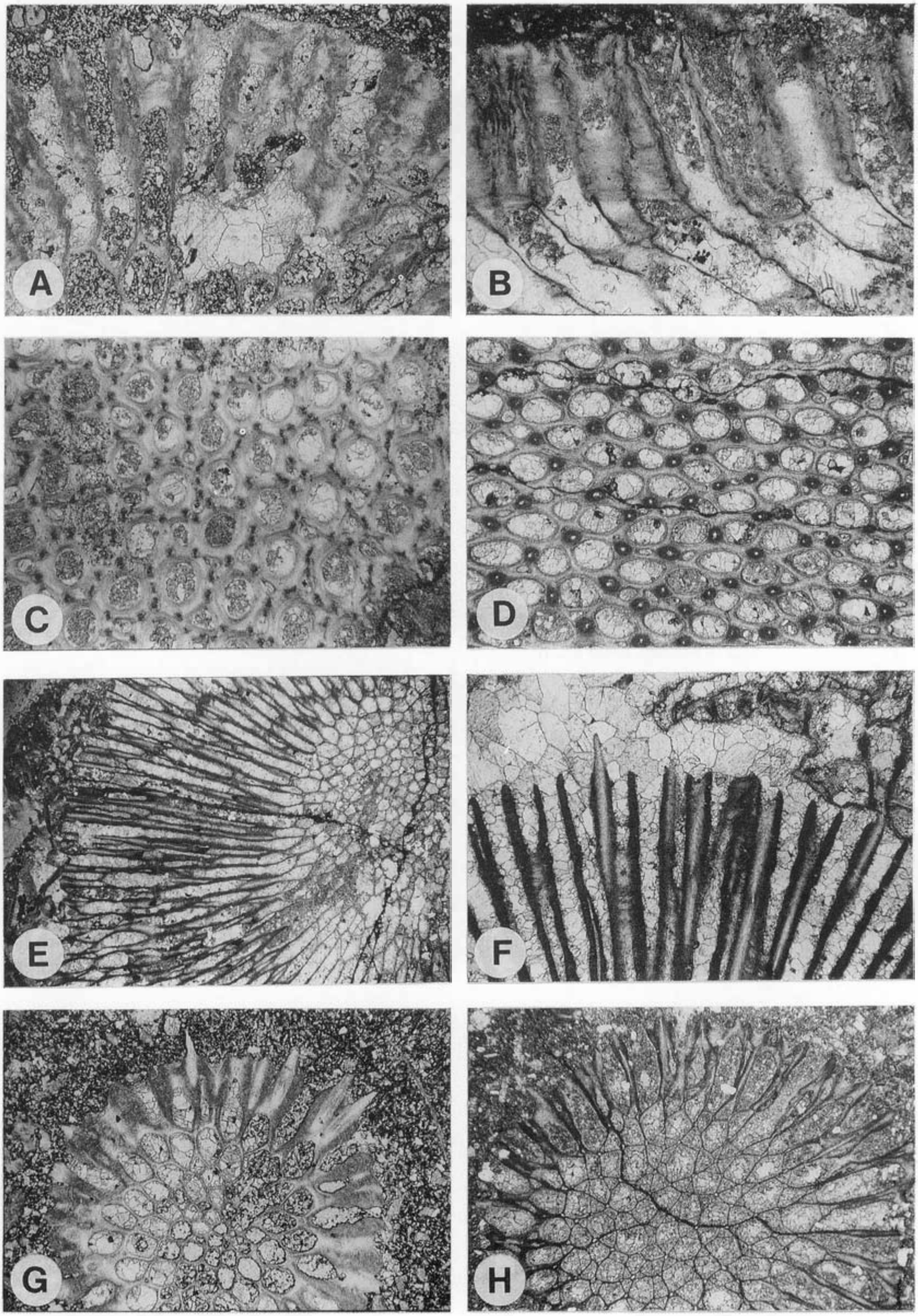

Plate 7

A, B	*Dyscritella minuta* Morozova
A	Longitudinal section, AKS–A–1.3m, PMO A42660/2, x25
B	Tangential section, AKS–A–1.3m, PMO A42659/2, x25
C–F	*Dyscritella* sp. A.
C	Transverse section of specimen encrusting ?*Rhombotrypella*, AKS–A–11.8m, PMO 132.063/2, x10
D	Tangential section, AKS–A–9.5m, PMO A42665/B, x25
E	Specimen encrusting crinoid stem, KWÆ–1–0.15m, PMO A42271, x15, petrographic thin section
F	Longitudinal section, AKS–A–9.5m, PMO A42665/A, x25
G, H	Trepostome gen. et sp. indet. (encrusting a (now) silicified brachiopod)
G	AKS–A–11.8m, PMO 132.057/3, x25
H	AKS–A–11.8m, PMO 132.057/2, x25

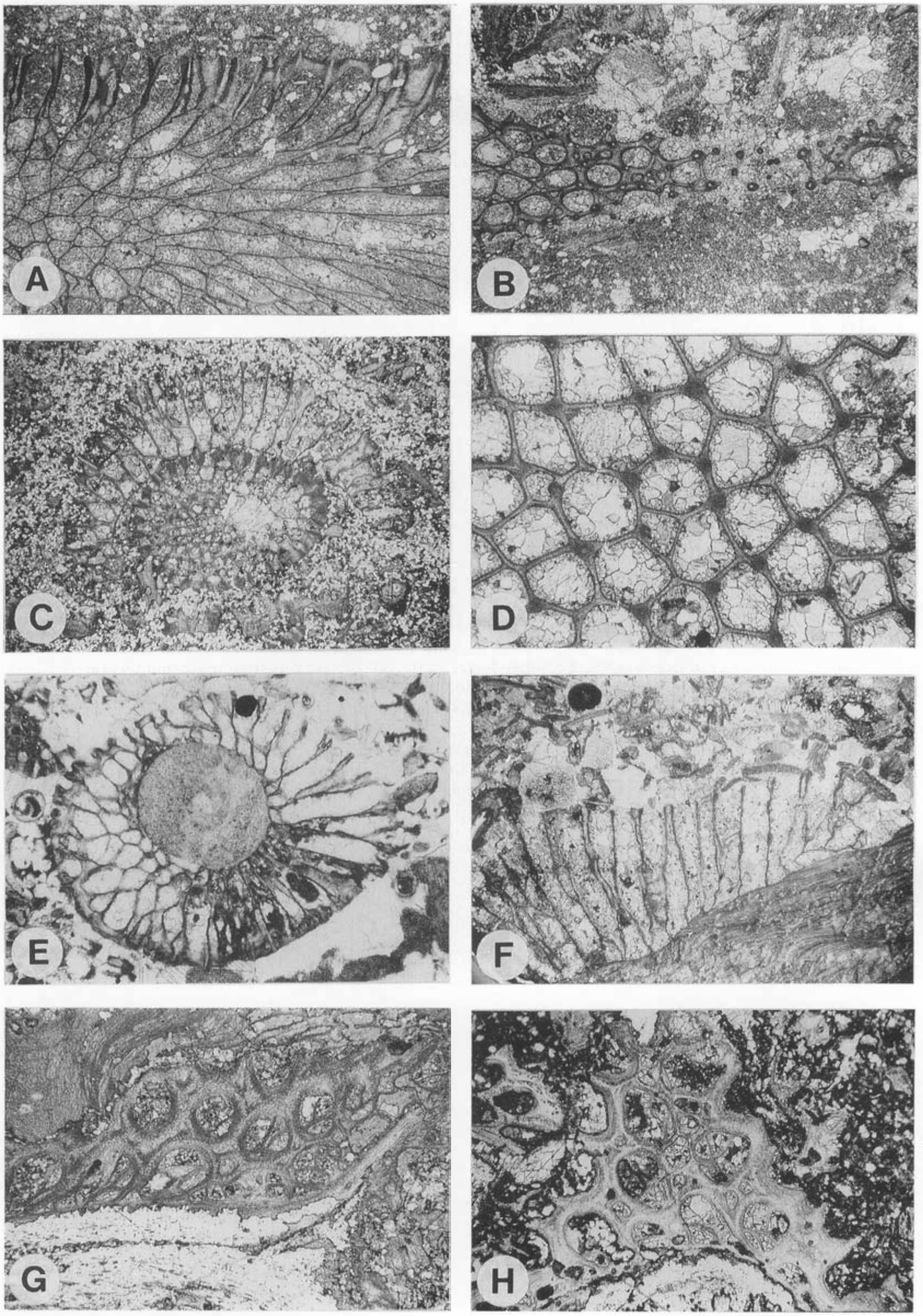
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Plate 8

A, D, F	*Primorella* cf. *polita* Romanchuk & Kiselëva
A	Oblique transverse section, FES–10–15.0m, PMO 138.093, x25
D	Tangential section, FES–10–15.0m, PMO 138.093, x25
F	Oblique longitudinal section, FES–10–15.0m, PMO 138.093, x25
B, E, G	*Clausotrypa monticola* (Eicwald)
B	Transverse section, FES–10–15.0m, PMO 138.083/1, x25
E	Oblique tangential section showing distinct acanthostyles and striated wall structure, FES–10–15.0m, PMO 138.083/1, x25
G	Transverse section of specimen being used as a holdfast for a colony of *Polypora*, AKS–A–11.8m, PMO 132.062/2, x25
I–K	*Streblascopora germana* (Bassler)
I	Longitudinal section close to point of bifurcation displaying central bundle of parallel zooecial tubes, FES–10–15.0m, PMO A42279, x25, petrographic thin section
J	Tangential section, FES–10–15.0m, 132.120, x25
K	Oblique tangential section, FES–10–15.0m, PMO A42279, x25, petrographic thin section
C, H	*Permoheloclema merum* Ozhgibesov
C	Transverse section, AKS–A–7.0m, PMO A42650/4, x25, petrographic thin section
H	Transverse section close to point of bifurcation, AKS–A–7.0m, PMO A42650/1, x25, petrographic thin section

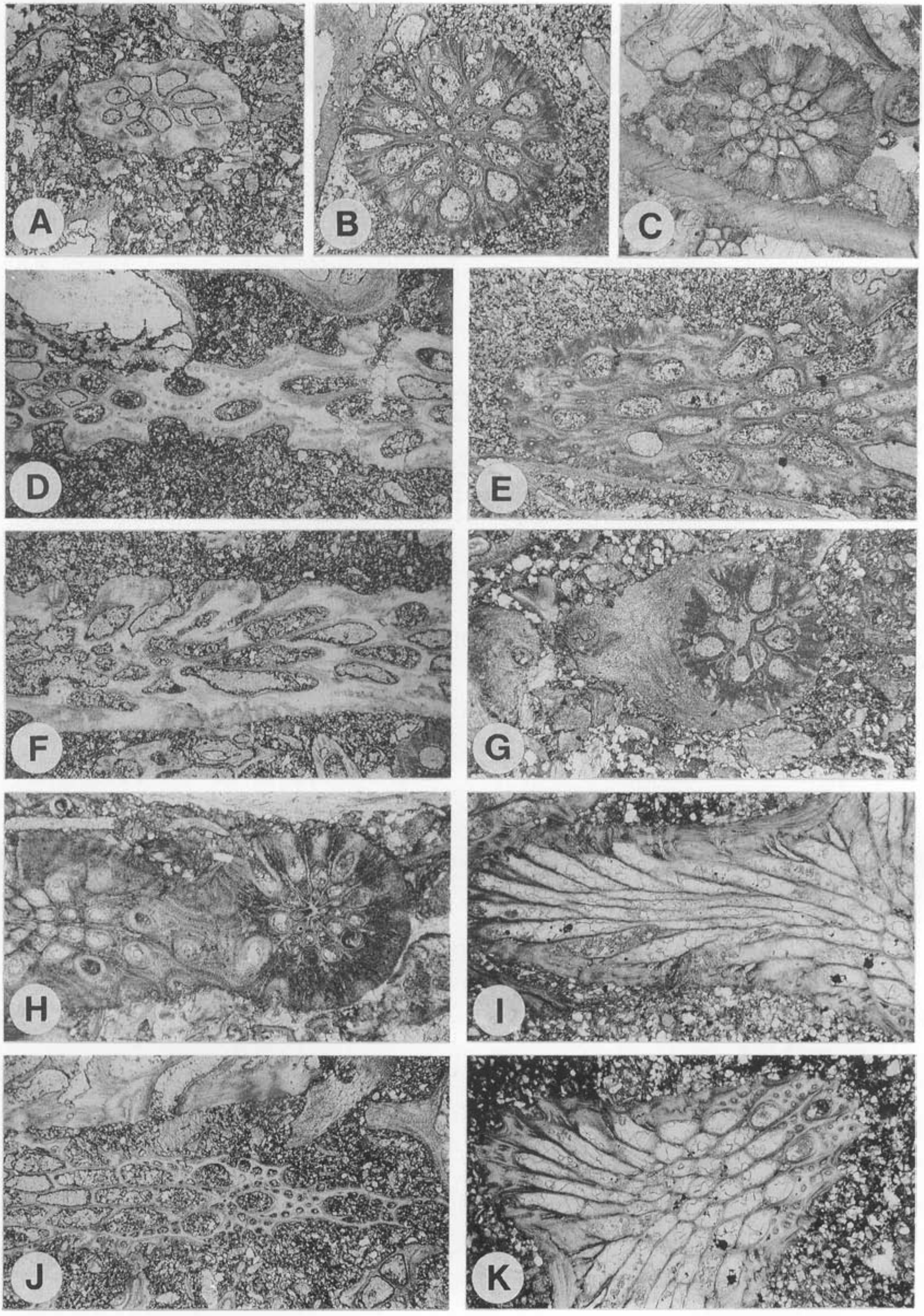
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Plate 9

A–E	*Timanodictya nikiforovae* Morozova
A	Oblique transverse section, FES–10–15.0m, PMO 138.096/1, x25
B	Transverse section of distal branch overgrown by ?*Polypora*, AKS–A–8.0m, PMO A42681/A, x25
C	Oblique transverse section showing large capillaries (arrow). AKS–A–8.0m, PMO A42681/E, x25
D	Tangential section, FES–10–15.0m, PMO 138.096/1, x25
E	Basal holdfast and several initial layers of *T. nikiforovae* growing within *Meekopora magnusi*, AKS–A–5.0m, PMO 118.078/1, x10
F–H	*Girtyporina* sp.
F	Tangential section of zooecial apertures and fozzazooecia openings (arrow), AKS–A–8.0m. PMO 132.102/1, x25
G	Oblique section with maculum (arrow), FES–10–10.0m, PMO 118.156, x25
H	Oblique longitudinal section showing encrusting base on a brachiopod shell, FES–10–10.0m, PMO 118.156, x25

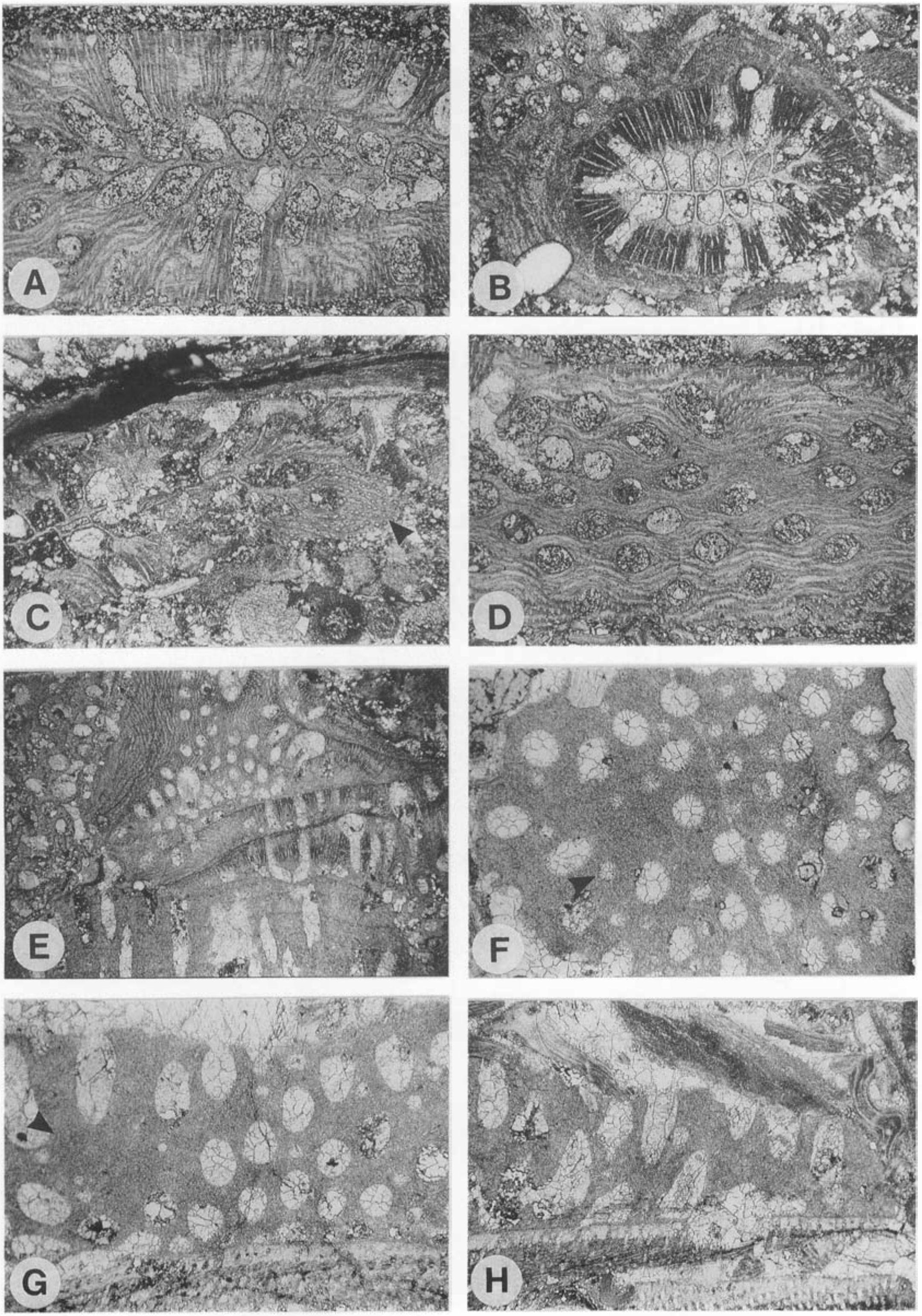
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Plate 10

A–D	*Fenestella akselensis* sp. nov.
A	Tangential section showing position of carinal nodes, AKS–A–7.0m, PMO A42695, x25
B	Median tangential section, AKS–A–5.0m, PMO A42677, x25
C	Oblique transverse section, AKS–A–7.0m, PMO A42696, x25
D	Longitudinal section, AKS–A–5.0m, PMO A42677, x25
E–I	*Fenestella reversicnotta* sp. nov.
E	Slightly oblique transverse section, AKS–A–1.3m, PMO A42658/2, x25
F	Longitudinal section, AKS–A–1.3m, PMO A42657, x25
G	Reverse surface showing nodes (arrow), AKS–A–5.0m, PMO A42643, x25
H	Median tangential section, AKS–A–5.0m, PMO A42643, x25
I	Shallow tangential section showing placement of obverse nodes, AKS–A–1.3m, PMO A42658/2, x25

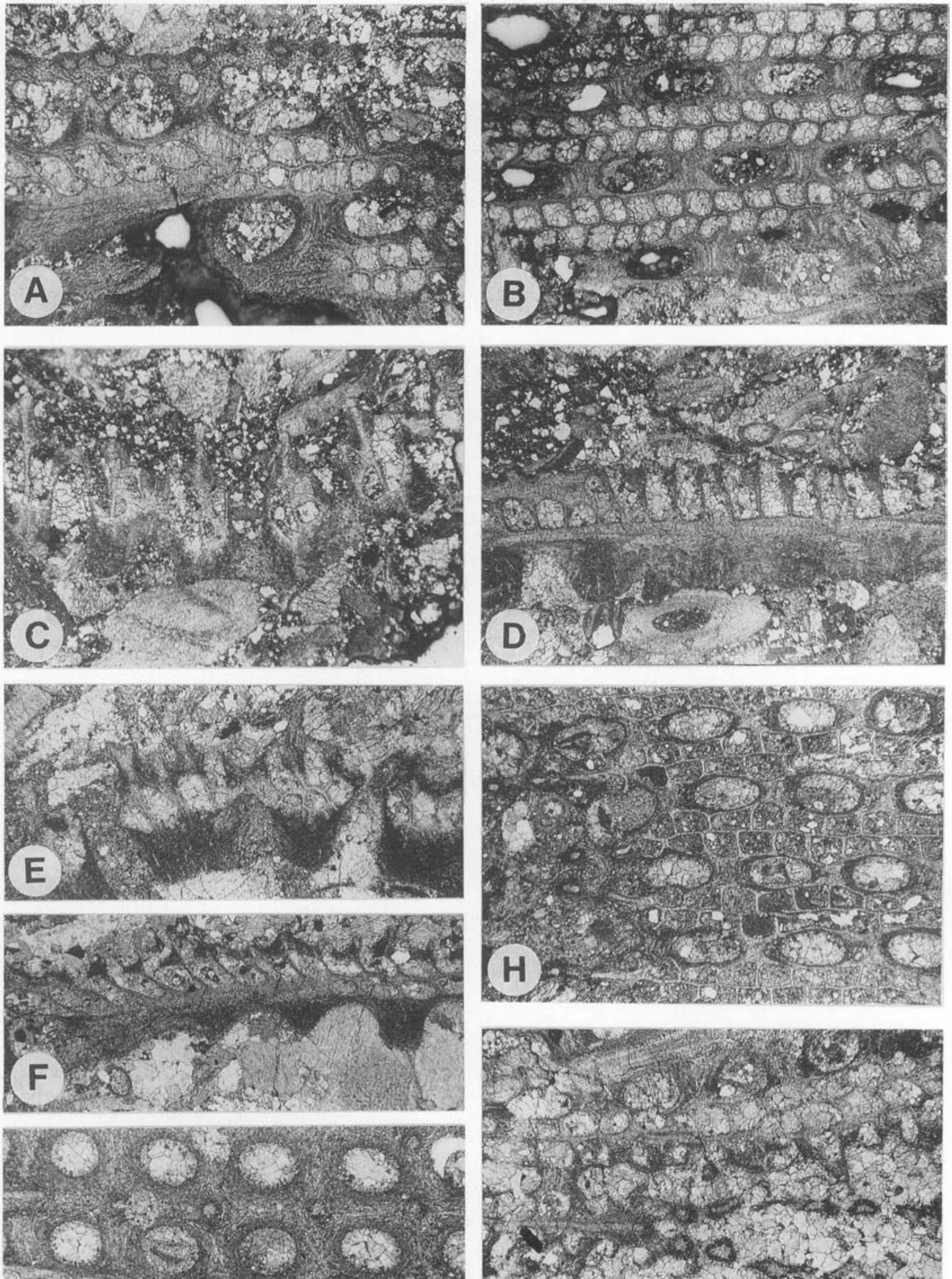
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Plate 11

A, B	*Fabifenestella* sp. B.
A	Tangential section, AKS–A–11.8m, PMO 118.195, x10
B	Shallow to median deep tangential section, AKS–A–11.8m, PMO 118.195, x25
C–F	*Rectifenestella microporata* (Shul'ga–Nesterenko)
C	Shallow tangential section showing distinct nodes and fenestrules closed off by secondary calcification (arrows), AKS–A–1.3m, PMO 118.108, x25
D	Transverse section showing distinct reverse thickening, AKS–A–3.0m, PMO 118.054, x25
E	Shallow to deep tangential section, AKS–A–1.3m, PMO 118.108, x25
F	Longitudinal section showing distinct reverse thickening, AKS–A–3.0m, PMO 118.054, x25
G, H	*Rectifenestella retiformis* (Schlotheim)
G	Shallow tangential section, FES–10–15.0m, PMO 138.080/2, x25
H	Longitudinal section, AKS–A–7.0m, PMO 132.075/1, x25

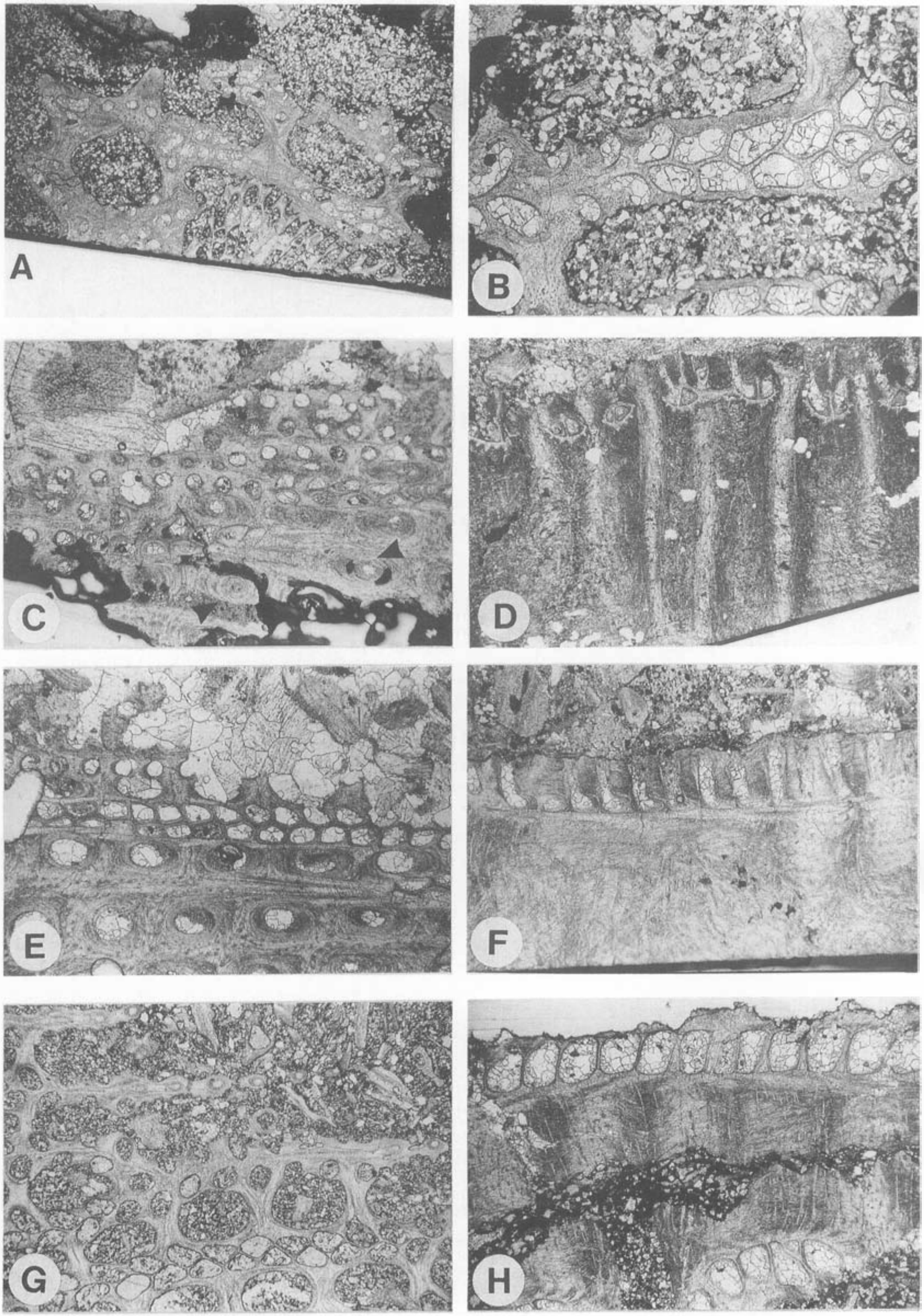
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Plate 12

A, B	*Rectifenestella retiformis* (Schlotheim)
A	Oblique transverse section, AKS–A–7.0m, PMO 132.075/1, x40
B	Oblique transverse section with appendage, AKS–A–7.0m, PMO 132.075/2, x25
C–E	*Rectifenestella* sp. A.
C	Oblique longitudinal section, FES–10–15.0m, PMO A42087, x25
D	Shallow tangential section showing carinal nodes, FES–10–15.0m, PMO A42087, x25
E	Median to deep tangential section (partly silicified zooecial chambers), FES–10–15.0m, PMO A42087, x25
F	*Rectifenestella* sp. B.
	Median to deep tangential section, FES–10–15.0m, PMO A42085, x25
G	*Alternifenestella subquadratopora* (Shul'ga–Nesterenko)
	Oblique tangential section including reversal nodes, FES–10–15.0m, PMO 132.121/2, x25
H	*Alternifenestella bifida* (Eichwald)
	Oblique tangential section, FES–10–15 0m, PMO 132.121/1, x25
I	*Alternifenestella* cf. *minuscula* Morozova
	Tangential section of partly crushed specimen, AKS–A–11.8, PMO 132.118/2, x25

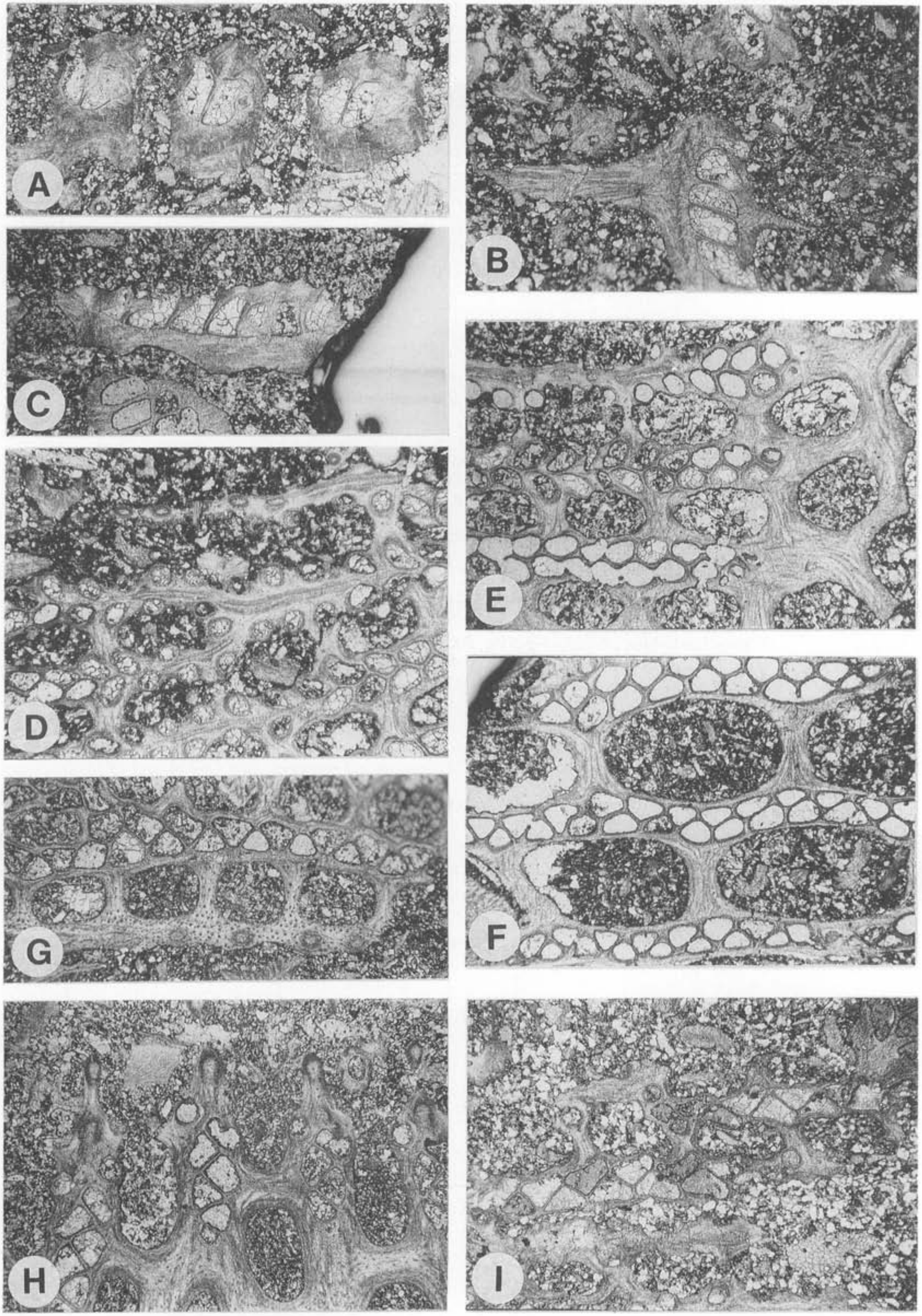
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Plate 13

A	*Alternifenestella* cf. *greenharbourensis* (Nikiforova) Tangential section, AKS–A–11.8m, PMO 132.063/1, x25
B, C	*Alternifenestella* sp. A.
B	Deep tangential section, FES–10–15.0m, PMO 138.075, x25
C	Tangential section, FES–10–15.0m, PMO 138.075, x10
D–H	*Lyropora serissima* sp. nov.
D	Tangential section, KWÆ–1–1.55m, PMO A42152/1, x10
E	Shallow tangential section showing place of large nodes (arrows), KWÆ–1–0.15m, PMO A42274, x25, petrographic thin section
F	Shallow tangential section showing stylets in zooecial apertures (arrows), KWÆ–1–0.15m, PMO A42274, x40, petrographic thin section
G	Transverse section, KWÆ–1–1.55m, PMO A42152/2, x25
H	Longitudinal section, KWÆ–1–0.15m, PMO A42274, x25, petrographic thin section

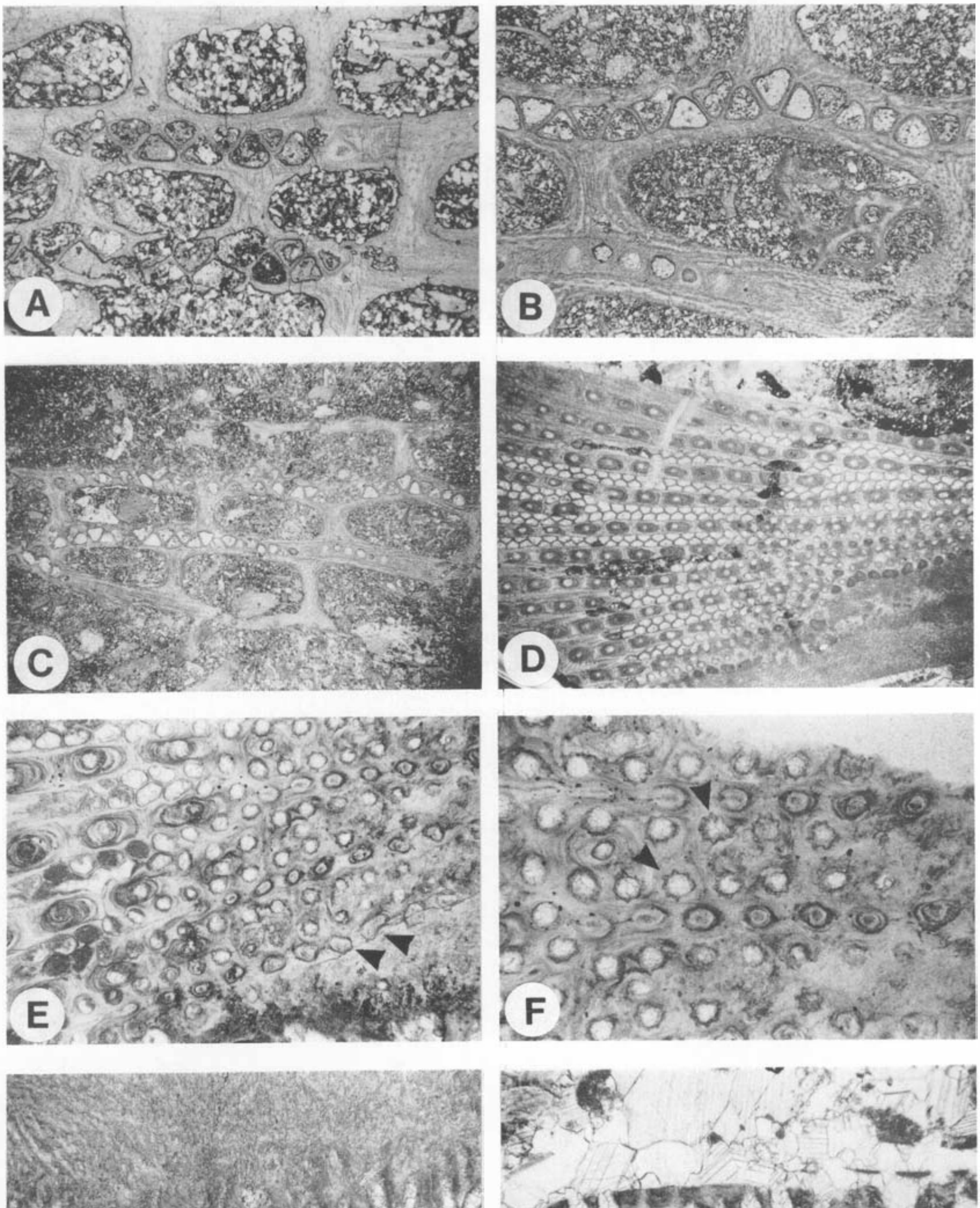
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Plate 14

A–D	*Lyropora serissima* sp. nov.
A	Polished rock specimen showing the arched zoarium, KWÆ–1–1.55, PMO A42152, x2.5, holotype
B	Transverse section of zooecial apertures facing down, KWÆ–1–1.55m, PMO A42152/2, x10
C	Shallow tangential section showing very large nodes (arrows), KWÆ–1–1.55m, PMO A42152/1, x25
D	Deep tangential section with fenestrules almost closed off by secondary calcification, KWÆ–1–1.55m, PMO A42152/1, x25
E–H	*Polyporella borealis* (Stuckenberg)
E	Median tangential section with large nodes visible (upper left), FES–10–4.0m, A42091, x25
F	Rock specimen, AKS–A–6.0m, PMO 132.074, x1.8
G	Longitudinal section, AKS–A–9.5m, PMO 118.066, x25
H	Slightly oblique transverse section showing heavy reversal calcification, FES–10–4.0m, A42091, x25

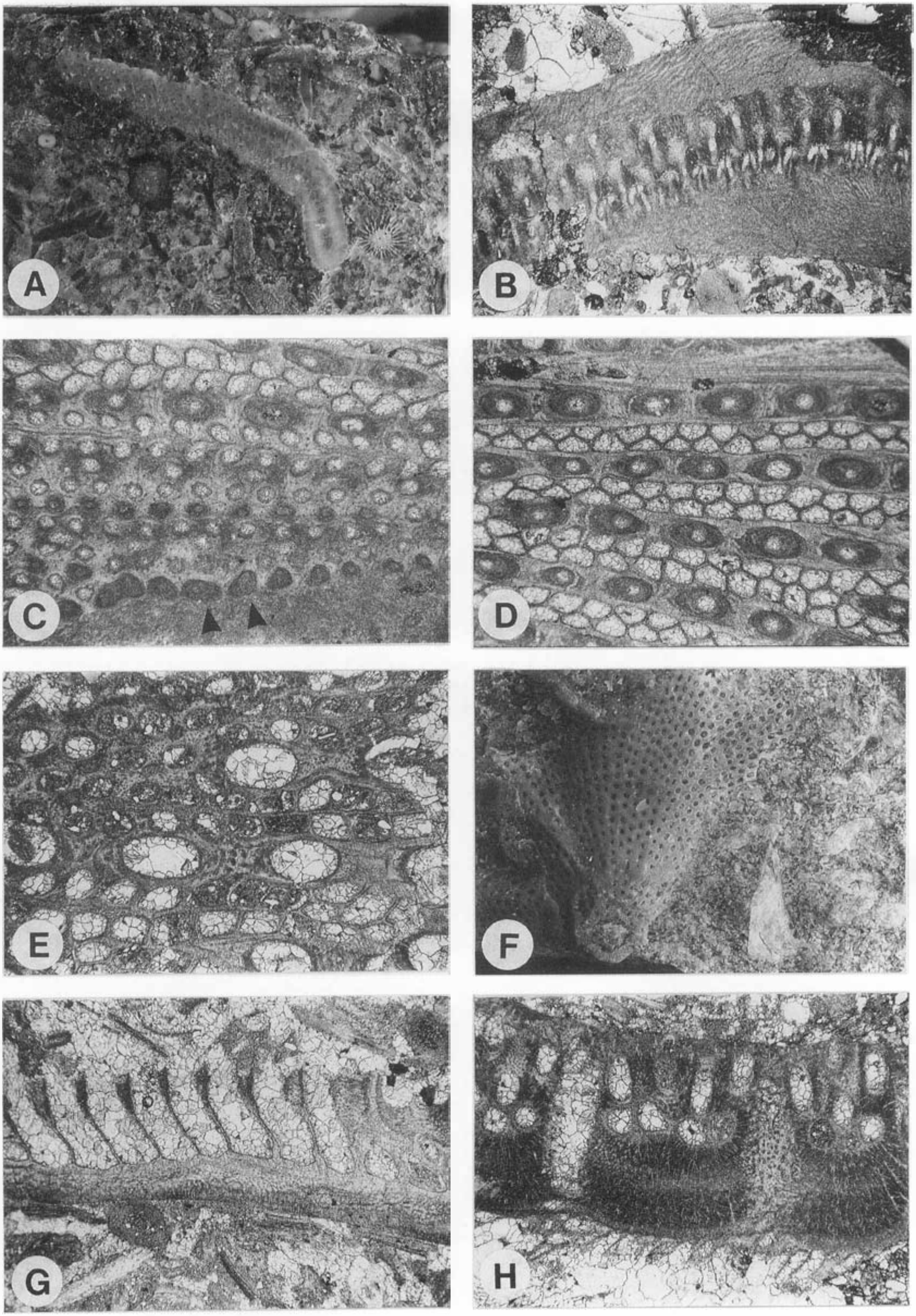
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Plate 15

A	*Penniretepora* sp. B.
	Median tangential section, FES–10–15.0m, PMO 138.077, x25
B, D	*Polyporella biarmica* (Keyserling)
B	Shallow to median deep tangential section, AKS–A–4.5m, PMO 132.097, x25
D	Deep tangential section, AKS–A–4.5m, PMO 132.097, x25
C, E	*Polypora brevicellata* Baranova
C	Shallow tangenial section displaying a spotty surface, FES–10–15.0m, PMO 138.079, x25
E	Tangenial section, FES–10–15.0m, PMO 138.078, x10
F–I	*Polypora martis* Fischer de Waldheim
F	Very shallow section showing large tubercles (arrows) between apertures, AKS–A–7.0m, PMO 118.055/4, x25
G	Longitudinal section, AKS–A–7.0m, PMO 118.055/3, x25
H	Tangential section, AKS–A–7.0m, PMO 118.056, x10
I	Transverse section, FES–10–4.0m, PMO 118.087, x25

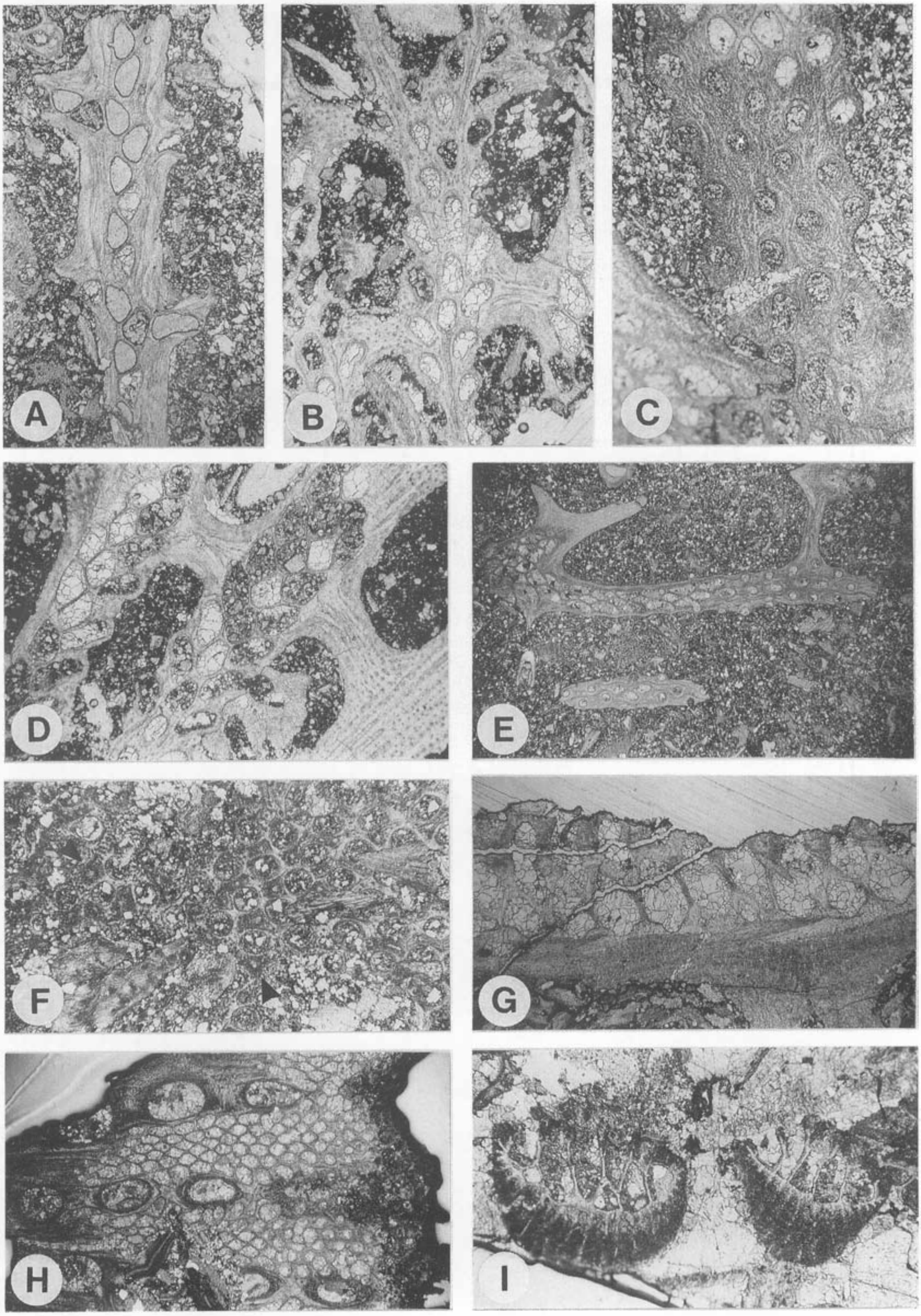
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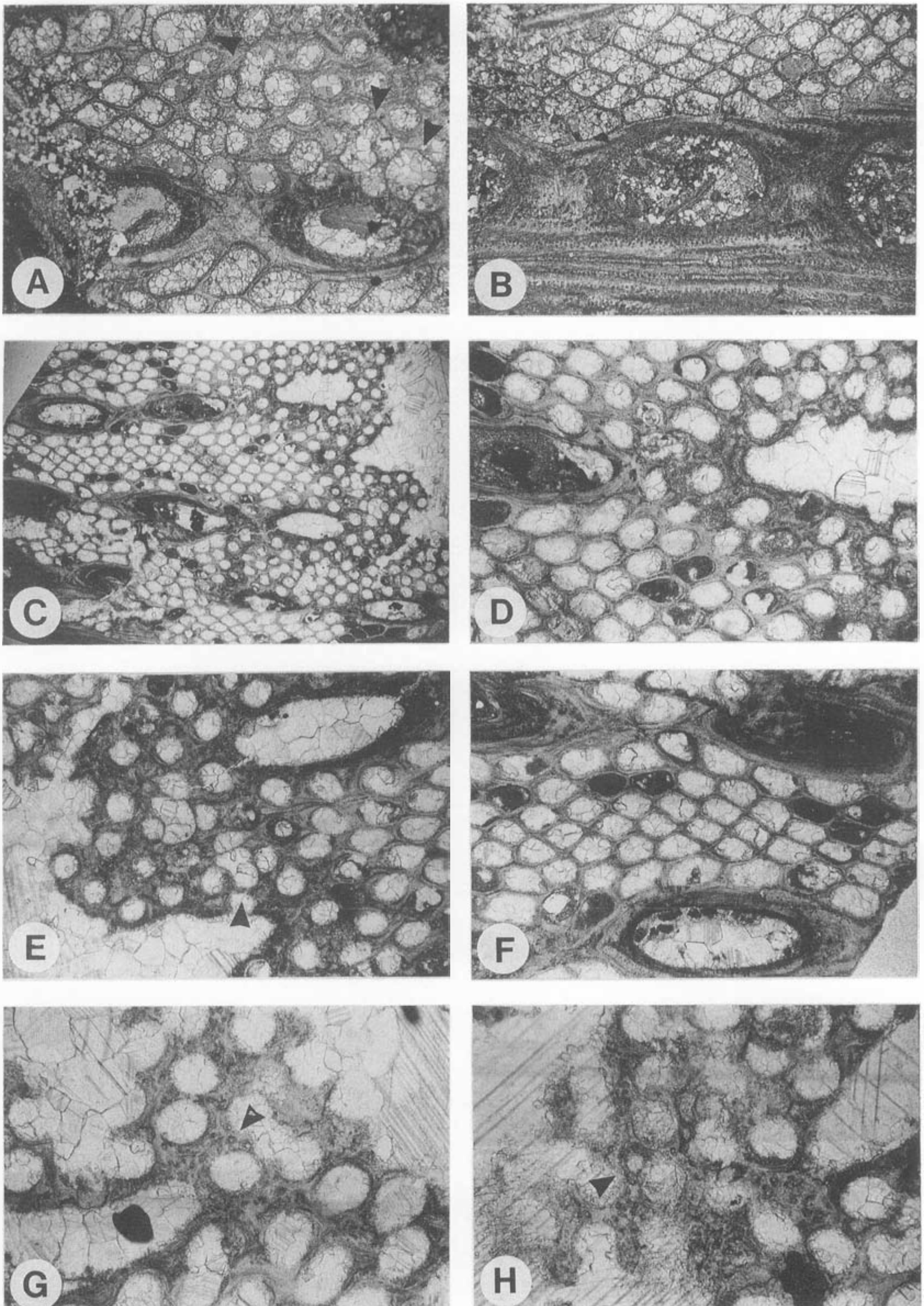
Plate 16

A, B	*Polypora martis* Fischer de Waldheim
A	Median tangential section showing occurrence of ovicells (arrows), AKS–A–7.0m, PMO 118.056, x25
B	Deep to reverse tangential section showing striated reverse side of branches, AKS–A–7.0m, PMO 118.056, x25
C–H	*Protoretepora* sp. A.
C	Tangential section, KWÆ–1–0.15m, PMO A42273, x10, petrographic thin section
D	Shallow tangential section showing apertures indenting fenestrule, KWÆ–1–0.15m, PMO A42273, x25, petrographic thin section
E	Shallow tangential section showing ovicells (arrow), KWÆ–1–0.15m, PMO A42273, x25, petrographic thin section
F	Deep tangential section, KWÆ–1–0.15m, PMO A42273, x25, petrographic thin section
G	Shallow tangential section showing abundant small tubercles between apertures (arrow), KWÆ–1–0.15m, PMO A42273, x40, petrographic thin section
H	Shallow tangential section showing scattered large tubercles between apertures (arrow), KWÆ–1–0.15m, PMO A42273, x40, petrographic thin section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