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Bryozoans from the Artinskian (Lower Permian) Great Bear Cape Formation, Ellesmere Island (Canadian Arctic)

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ABSTRACT: Samples containing bryozoans collected during the 1898–1902 expedition of the 'Fram' to the Canadian arctic islands have been reinvestigated. A small amount of calcareous rock derived from the Artinskian Great Bear Cape Formation has yielded a very rich bryozoan fauna comprising 37 taxa (four of the Order Cystoporida, six of the Order Trepostomida, seven of the Order Rhabdomesonida, one of the Order Cryptostomida, one of the Order Phylloporinida and eighteen of the Order Fenestrida). The faunal composition when compared with contemporaneous units of adjacent Arctic areas shows most similarity to Spitsbergen and Timan-Pechora. The bryozoans support the ages previously known from conodont occurrences.

1 INTRODUCTION

The investigated material was collected during the 1898–1902 'Second Expedition in the Fram' to the Canadian Arctic islands (Figure 1). The collection is now housed in the Geological Museum (former Palaeontological Museum) (prefix PMO), University of Oslo, Norway, and the figured bryozoans herein are kept in the collection of type and illustrated material. The expedition was under Captain Otto Sverdrup's (1854–1930) leadership, and undertook botanical, geographical, geological and zoological investigations in the unmapped Arctic area. Per Schei (1875–1905) was the expedition geologist, and he was responsible for collecting the samples investigated here.

The plan of the expedition was to return home in 1900, but they were unable to get out of the ice in Gaasefjorden [Goose Fjord] until the following year. The fourth and unintended 1902 season of the expedition was also utilized for maximum exploration. The men travelled as far as to the northern tip of Ellesmere Island (a distance of 635 kilometres) with dogs and sleds, and collected thousands of geological samples. Material was sent to experts worldwide after the expedition, and 38 scientific reports were published.

The Colin Archer constructed vessel *Fram* was used, prior to the Canadian expedition, by Fridtjof Nansen (1861–1930) during his 1893–1896 North Pole expedition (Polar Sea), but he had to head back to Norway without reaching the Pole. Roald Amundsen (1872–1928) later used *Fram* for his successful South Pole expedition in 1910–1912. The vessel is now on display in the Fram Museum in Oslo, Norway.

Bryozoan samples have previously been published from the *Fram* collection, but identifications were primarily based on external features – only a few thin sections were made (Tschernyschew & Stepanov, 1916).

2 METHODS

The current investigation is based on material from the same locality, Great Bear Cape [Store Bjørnekap] on the Bjorne Peninsula, SW Ellesmere Island, and from the same stratigraphic unit, the Great Bear Cape (GBC) Formation. The museum collection contains both specific samples with visible bryozoans, mainly fenestrates, and also larger bioclastic limestone samples which were cut to obtain bryozoans in different internal orientations. 140 thin sections and 70 acetate peels were prepared for this study.

3 GEOLOGICAL SETTING

When Tschernyschew & Stepanov (1916) published their paper on brachiopods and bryozoans, the investigated unit was believed to be of Late Carboniferous age (see also Schei in Sverdrup, 1904). Since then,

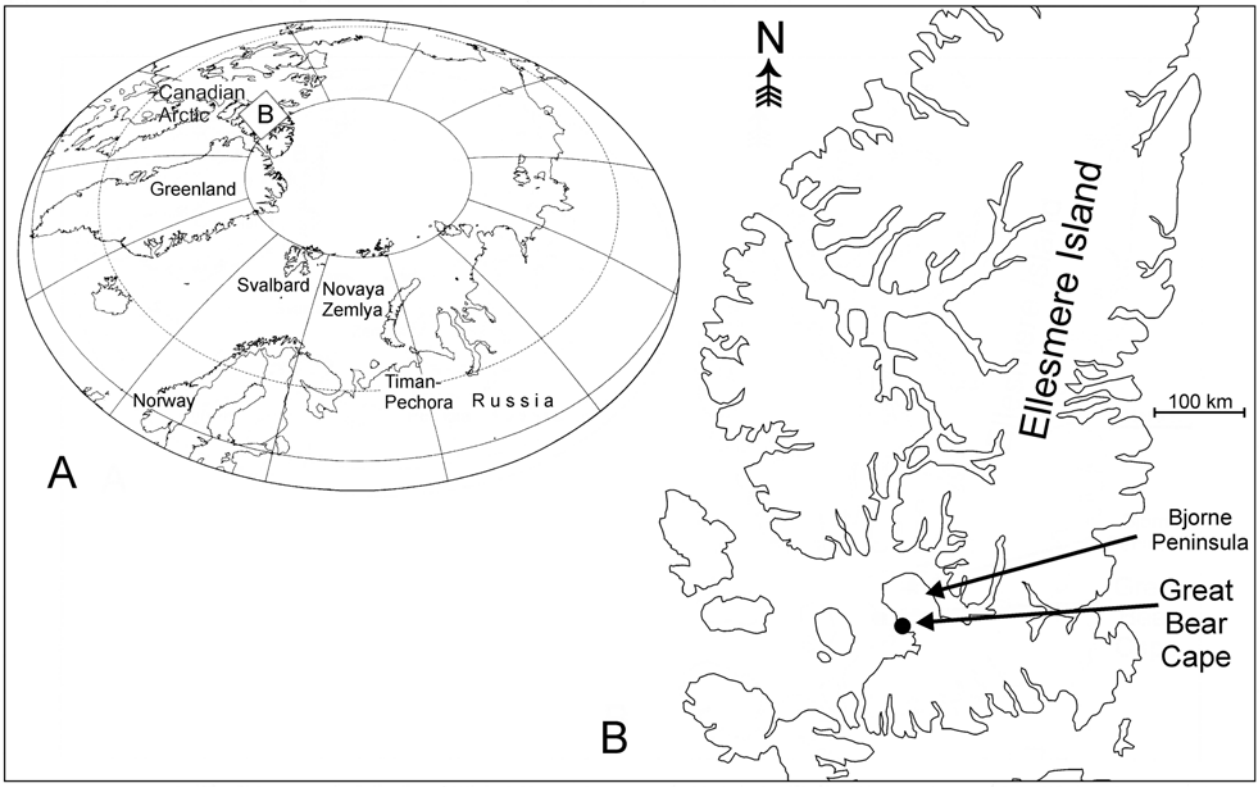

Figure 1. A. Map of the Arctic indicating inset map (B). B. Map of Canadian Arctic Islands with localities mentioned in the text.

comprehensive work has been carried out on the geology of the Canadian Arctic islands – the Sverdrup Basin – by P. Harker, R. Thorsteinsson, E.T. Tozer, B. Beauchamp and C.M. Henderson, and the modern stratigraphic definitions are presented in detail in Beauchamp & Henderson (1994).

It is uncertain whether P. Schei collected the bryozoan samples from talus or from bedrock. It is, however, certain that his samples are from the 'Great Bear Cape Limestone', which Thorsteinsson (1974) correlated with the Late Permian Degerböls Formation. The rocks below the 'Great Bear Cape Limestone' were in the same work correlated with the Assistance Formation (Ufimian) elsewhere in the Canadian Arctic. Prior to Thorsteinsson's work Nassichuk et al. (1965) reported Artinskian ammonoids in the 'Assistance Formation' here, causing more stratigraphic confusion, and work began to re-investigate the rocks. The 'Great Bear Cape Limestone' continued as the 'Unnamed Formation' in subsequent publications (e.g. Beauchamp et al., 1989), until new fieldwork by B. Beauchamp and C.M. Henderson (1984–1992) revealed what is now the accepted modern stratigraphic scheme.

The lower part of the 'Unnamed Formation', i.e. the succession correlated as Assistance Formation by Thorsteinsson (1974), is now included in the Raanes Formation; the upper part of the 'Unnamed Formation', i.e. the succession correlated as Degerböls Formation by Thorsteinsson (1974), is now included in the Great Bear Cape Formation (Figure 2).

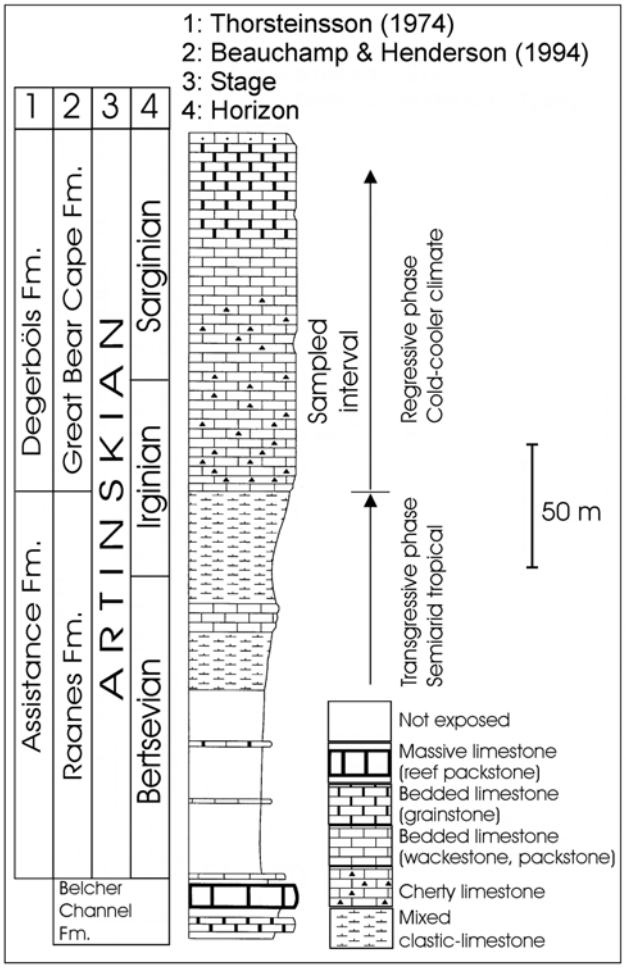

Figure 2. Lithological log, stratigraphy and geological development of the investigated units. Modified from Beauchamp & Henderson (1994).

The Great Bear Cape Formation is defined by Beauchamp & Henderson (1994) as 'a unit of resistant, yellowish-weathering, pure to locally sandy, variably cherty, highly fossiliferous limestone that overlies either the Raanes or the Trappers Cove formations' (Figure 2). The top of the unit is stripped off at the Bjorne Peninsula locality. Rich conodont faunas contain species of *Adetognathus*, *Sweetognathus*, *Neostreptognathodus* and *Mesogondolella*, placing the unit in the P6b, P7 and P8 (Artinskian) and the top in the P9 (Artinskian-Kungurian) conodont zones of Beauchamp et al. (1989). As the top is stripped off where the current material derives from, the age of the investigated bryozoan fauna is most probably Artinskian. For further discussion of the stratigraphic problem see Beauchamp & Henderson (1994).

4 BRYOZOAN FAUNA

70 acetate peels and 140 thin sections have been prepared from selected samples from the Great Bear Cape Formation. These samples have revealed a high diversity bryozoan fauna.

The following species of non-fenestellid orders have been identified:

Cystoporida: *Fistulipora volongensis* (Nikiforova, 1938); *Fistulipora* sp.; *Cyclotrypa distincta* (Morozova, 1986); *Ramiporidra variolata* (Shul'ga-Nesterenko, 1933); Trepostomida: *Tabulipora* spp.; *Stenophragmidium* sp.; *Rhombotrypella* cf. *amdrupensis* (Ross & Ross, 1962); *Dyscritella vulgata* (Gorjunova, 1972); *Dyscritella tenuis* (Kruchinina, 1973); *Ulrichotrypa ramulosa* (Bassler, 1929); Rhabdomesonida: *Pseudonematopora* sp.; *Streblascopora vera* (Morozova, 1986); *Streblascopora germana* (Bassler, 1929); *Clausotrypa monticola* (Eichwald, 1860); *Primorella superba* (Morozova, 1981); *Primorella tundrica* (Kruchinina, 1986); *Rhombopora* sp.; Cryptostomida: *Phragmophera* sp. n.; Phylloporinida: *Bashkirella operculata* (Shul'ga-Nesterenko, 1952). Selected taxa are illustrated in Figure 3.

The following species of the Order Fenestrida have been identified: *Alternifenestella bifida* (Eichwald, 1860); *Alternifenestella crassiseptata* (Shul'ga-Nesterenko, 1941); *Alternifenestella cyclotriangulata* (Eichwald, 1860); *Alternifenestella* cf. *invisitata* (Kruchinina, 1986); *Fabifenestella* cf. *subvirgosa* (Shul'ga-Nesterenko, 1952); *Fabifenestella* cf. *virgosa* (Eichwald, 1860); *Fabifenestella tortuosa* (Trizna & Klautsan, 1961); *Fenestella akselensis* (Nakrem, 1995); *Rectifenestella microporata* (Shul'ga-Nesterenko, 1939); *Rectifenestella robusta* (Shul'ga-Nesterenko, 1936); *Polypora confirmata* (Kruchinina, 1986); *Polypora kossjensis* (Ravikovich, 1948); *Polypora kutorgae* (Stuckenberg, 1895); *Polypora martis* (Fischer, 1837); *Polypora voluminosa* (Trizna & Klautsan, 1961); *Penniretepora invisa* (Trizna, 1939); *Acanthocladia* cf. *sparsifurcata* (Shul'ga-Nesterenko, 1939) and *Acanthocladia* cf. *rhombicellata* (Shul'ga-Nesterenko 1955). Selected taxa are illustrated in Figure 4.

The majority of these species have an Early Permian Sakmarian-Artinskian distribution in the Urals and the Timan-Pechora region of Russia, but a stratigraphical Artinskian-Kungurian range in Svalbard, Arctic Norway. The genus *Phragmophera* (Gorjunova, 1969), was originally described from the Upper Carboniferous of the Urals. The new species from the Great Bear Cape Formation is the second known species of this genus. The genus *Pseudonematopora* (Balakin, 1974), is quite exotic in Permian rocks; it is more commonly found in the Lower to Middle Carboniferous of Europe, Middle Asia, and Mongolia.

5 CONCLUSIONS

The Great Bear Cape Formation (Artinskian) ranges from the upper Irginian through most of the Sarginian Horizons as correlated with Western Siberian units (Morozova & Kruchinina, 1986), and is contemporaneous with most of the Artinskian Gipshuken Formation of Spitsbergen and the Hambergfjellet Formation of Bjørnøya (Nakrem et al., 1992). Presence/absence analysis of bryozoan species through different Early Permian units of the current Arctic regions is depicted in Figure 5. From this analysis it is evident that the faunal composition of the Great Bear Cape Formation is most similar to the Kungurian faunas of Spitsbergen (Svalbard), and that they form a group together with Kungurian faunas of Timan-Pechora (western Siberia), as well as with those of the Artinskian of Bjørnøya (Svalbard). Faunal migrations through time from the Sverdrup Basin to the Svalbard and Timan-Pechora Basins may explain this discrepancy in stratigraphic position. The Great Bear Cape Formation fauna is quite different from the Sakmarian and Artinskian faunas of Timan-Pechora.

As noted above, the Great Bear Cape Formation is well dated by conodonts, and the bryozoans support the correlations provided by conodonts when compared with adjacent Arctic regions, although many bryozoan species also range up into the Kungurian. The current investigation also clarifies questions raised in Morozova & Kruchinina (1986, p. 25) about their reported occurrence of the Artinskian species *Rhombotrypella invulgata* in the Belcher Channel (Sakmarian) and Assistance (Ufimian) Formations. The material described by Morozova & Kruchinina (1986) was collected from rocks at the time assigned to the Belcher Channel Formation and the Assistance Formation, but should be placed within the Great Bear Cape Formation according to the revised stratigraphical scheme by Beauchamp & Henderson (1994, pp. 564–565).

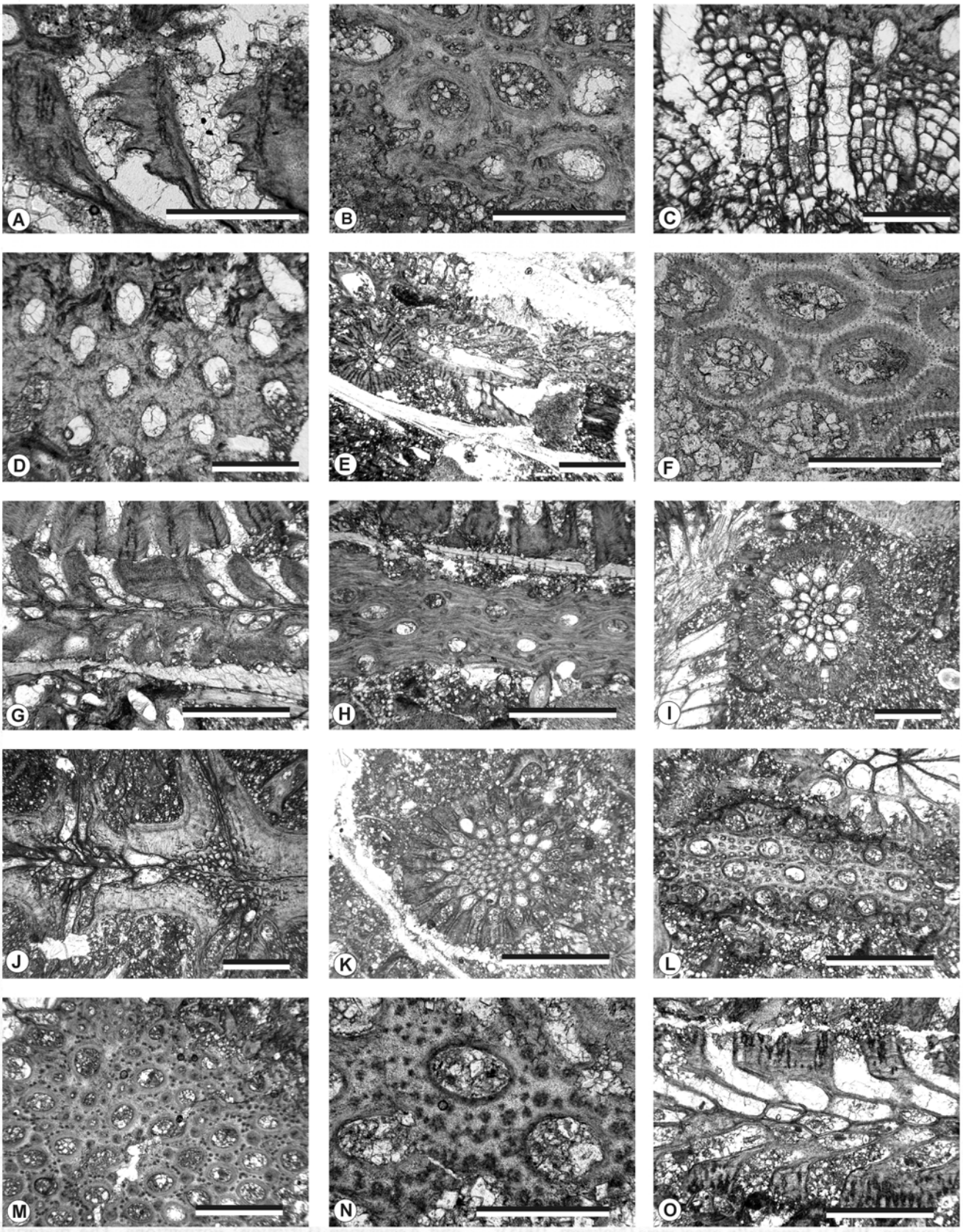

Figure 3. Non-fenestellid bryozoans. All are thin sections. Scale bars: 0.5 mm A–B, F, N; 1.0 mm C–E, G-M, O. A, B – Problematic trepostomid genus. A – PMO 203.518; B – PMO 203.513. C, D – *Cyclotrypa distincta* (Morozova, 1986), PMO 203.517. E – *Bashkirella operculata* Shul'ga-Nesterenko, 1952, PMO 203.518. F, G – *Phragmophera* sp. n. F – PMO 203.522; G – PMO 203.520. H, I – *Clausotrypa monticola* (Eichwald, 1860), H – PMO 203.521; I – PMO 203.516. J – *Ramiporidra variolata* (Shul'ga-Nesterenko, 1933), PMO 203.523. K, L – *Streblascopora vera* (Morozova, 1986), K – PMO 203.514; L – PMO 203.519. M – *Rhombotrypella* cf. *amdrupensis* (Ross & Ross, 1962), PMO 203.514. N, O: *Primorella superba* Morozova, 1981, PMO 203.515.

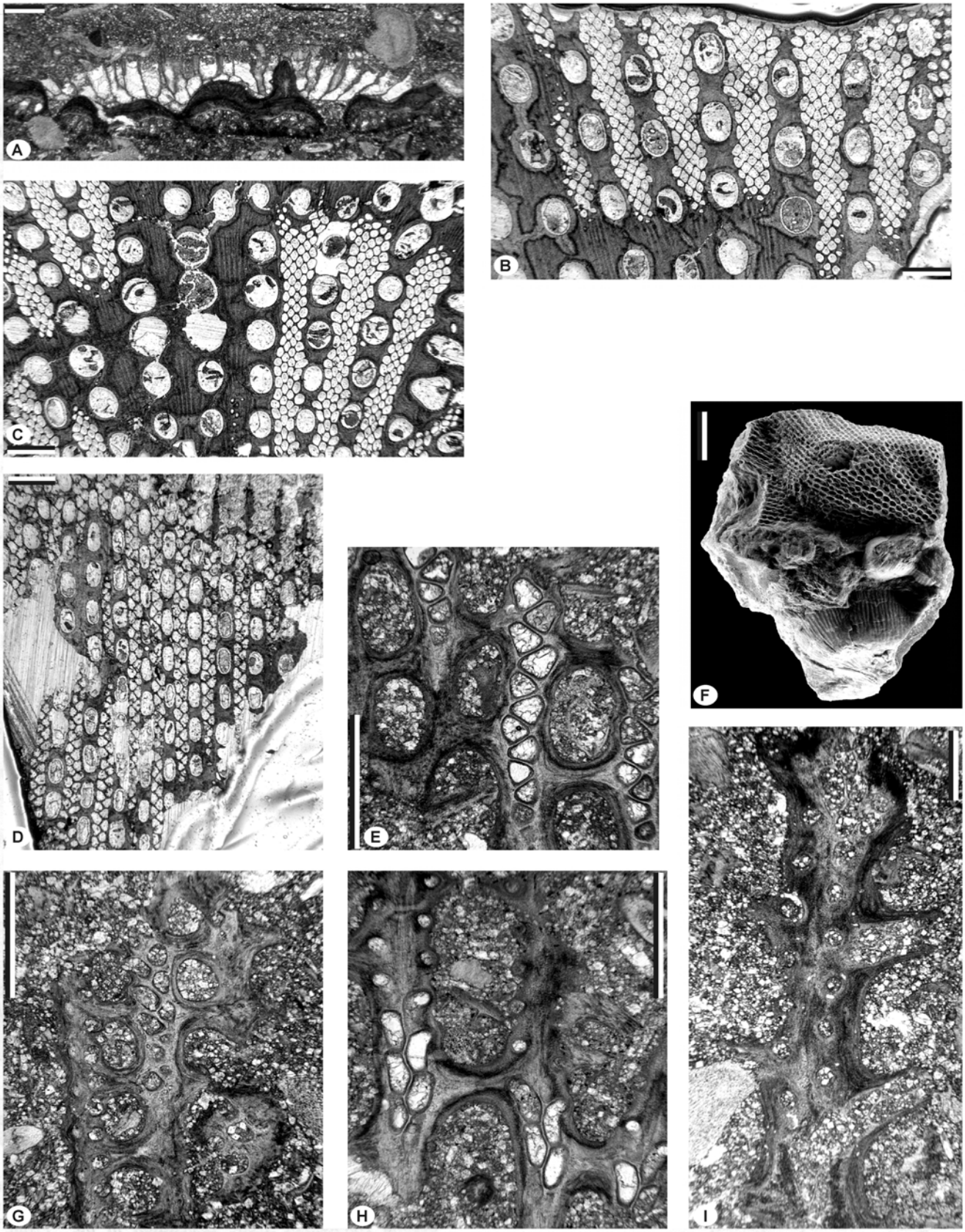

Figure 4. Trepostome and Fenestellid bryozoans. A – Encrusting trepostome (*?Stenophragmidium*) on reverse side of *Polypora* sp., thin section, PMO 203.524. B – *Polypora voluminosa* (Trizna & Klautsan, 1961), acetate peel, PMO A5301. C – *Polypora* cf. *martis* (Fischer, 1837), acetate peel, PMO A5289. D – *Rectifenestella* cf. *robusta* (Shul'ga-Nesterenko, 1936), acetate peel, PMO A5269. E – *Alternifenestella cyclotriangulata* (Eichwald, 1860), thin section, PMO 203.525. F – *Polypora martis* (Fischer, 1837), rock sample including other fossils, PMO A5294. G – *Rectifenestella microporata* (Shul'ga-Nesterenko, 1939), thin section, PMO 203.525. H – *Fabifenestella* cf. *subvirgosa* (Shul'ga-Nesterenko, 1952), thin section, PMO 203.526. I – *Penniretepora* sp., thin section, PMO 203.527. Scale bars: 1.0 mm A–E, G–I; 10 mm F.

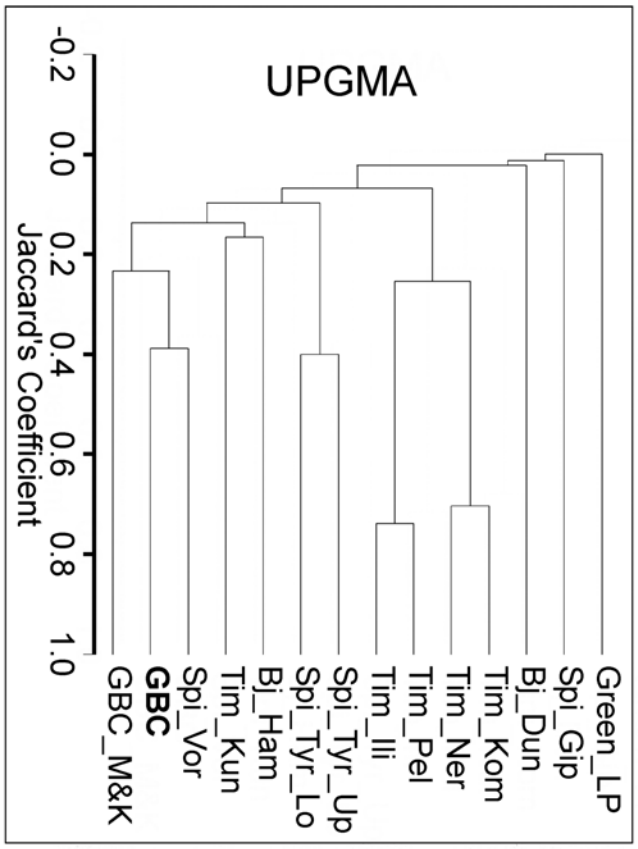

Figure 5. Cluster diagram (UPGMA, Unweighted Pair Group Method with Arithmatic Mean, MVSP, Kovach 2002) showing similarities between Lower Permian units of the Arctic region, analysis based on presence/absence of species from Great Bear Cape Formation, fauna lists in Morozova & Kruchinina (1986), and Nakrem (1994, 1995).
GBC = This study [Great Bear Cape Formation, Artinskian]
GBC_M&K = Great Bear Cape Formation (data from Morozova and Kruchinina 1986)
Bj_Dun = Bjørnøya, Svalbard [Kapp Dunér Formation, Asselian]
Bj_Ham = Bjørnøya, Svalbard [Hambergfjellet Formation, Artinskian]
Green_LP = North Greenland [Lower Permian]
Spi_Gip = Spitsbergen, Svalbard [Gipshuken Formation, Artinskian]
Spi_Tyr_Lo = Spitsbergen, Svalbard [Lower Tyrrellfjellet Member, Asselian]
Spi_Tyr_Up = Spitsbergen, Svalbard [Upper Tyrrellfjellet Member, Sakmarian]
Spi_Vor = Spitsbergen, Svalbard [Vøringen Member, Kungurian]
Tim_Ili = Timan [Ilibei, Lower Sakmarian]
Tim_Kom = Timan [Komichan, Upper Artinskian]
Tim_Kun = Timan [Kungurian]
Tim_Ner = Timan [Nerma, Lower Artinskian]
Tim_Pel = Timan [Pelsk, Upper Sakmarian]

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