

# **Fossil Bryozoa from Svalbard (Arctic Norway): a research history**

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1. Introduction
2. Research in the 19th century
3. Research in the 20th century
4. Recent years
5. Acknowledgements

## **1. Introduction**

Bjørnøya ("Bear Island") and some other islands of the Svalbard Archipelago were officially discovered by Willem Barents in 1596. The island was named "Het Beyren Eylandt" as a polar bear was observed during their visit. In the "Icelandic Annals" by Snorre, the discovery of a land called "Svalbard" was, however, recorded for the year 1194, and it is possible that this land is identical with the island named Spitsbergen today. It is probable that Norse seafarers hunting along the east coast of Greenland during whaling cruises also came across the isolated island of Bjørnøya. Early British expeditions named the island "Cherrie Island" after Sir Francis Cherrie. "Svalbard" is now the name covering all the islands in the archipelago, Bjørnøya is the southernmost island and Spitsbergen is the largest island (see Figure 1).

Several expeditions crossed the Barents Sea to Svalbard in the following years, primarily for whaling, but also for scientific observations, e.g. geographical mapping and oceanographic investigations.

## **2. Research in the 19th century**

1827 may be considered as the year when geological work began, when Baltazar Mathias Keilhau (1797–1858, professor in geology at the University of Christiania [Oslo], 1834–1857 (Figure 2)) set out with a German hunting expedition with the vessel "Haabet" ["Hope"] to Bjørnøya and Spitsbergen (Figure 3). Keilhau spent four days on Bjørnøya collecting botanical and geological material. Economical interest led to the investigation

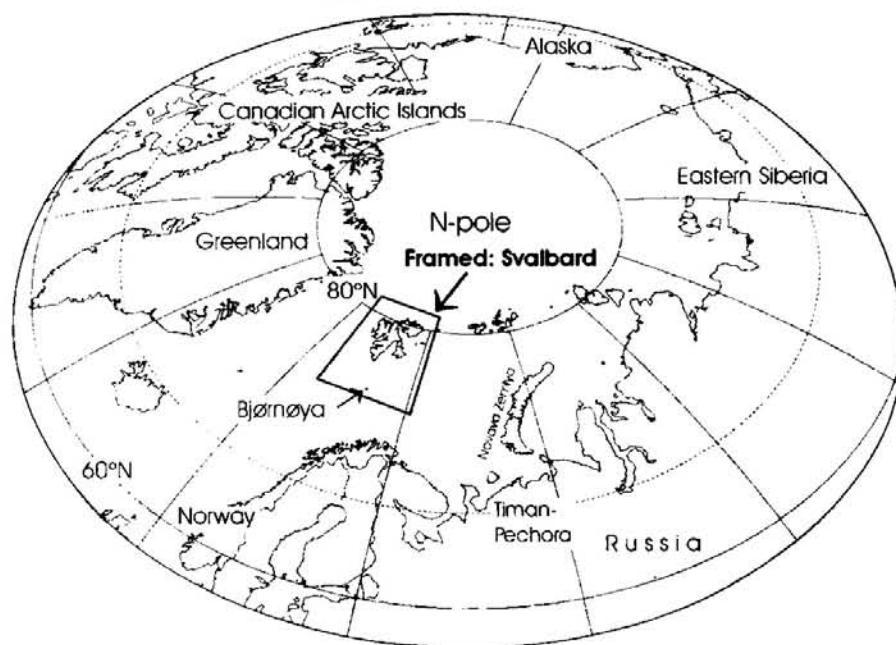
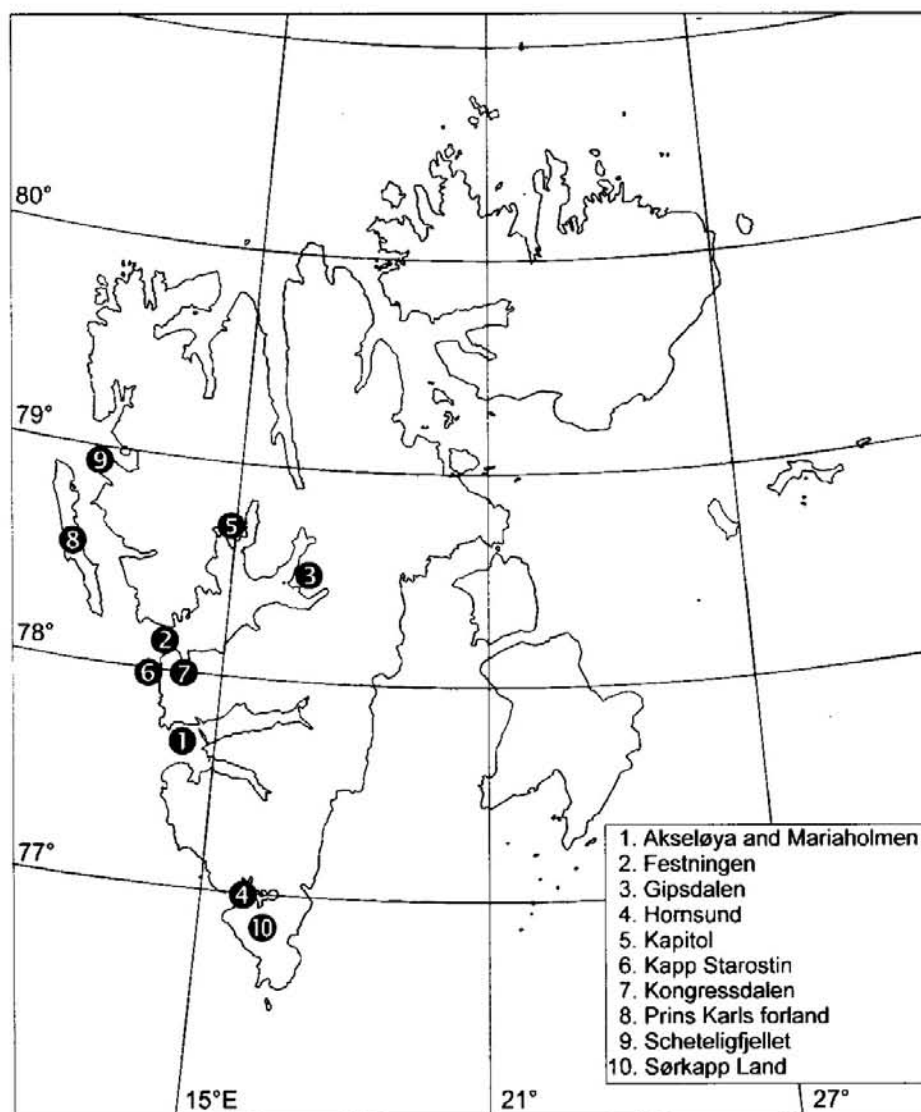


Figure 1. Map of Svalbard (top) and adjacent Arctic regions (bottom) with localities mentioned in the text.

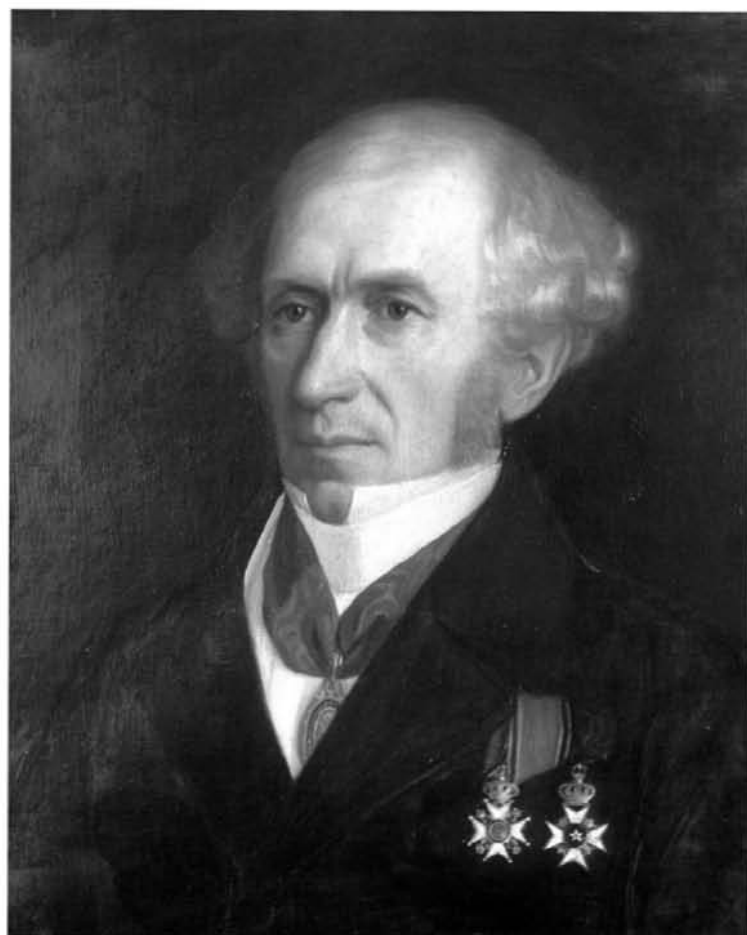


Figure 2. Baltazar Mathias Keilhau. Painting by Christiane Schreiber (c. 1857), on display in the Natural History Museum, University of Oslo.

of Devonian coal-bearing sandstones (“Steinkohlflötze”), but also the Permian “Productensandstein”, with its brachiopods and bryozoans, was sampled.<sup>1</sup> The brachiopods were handed over to Christian Leopold von Buch (1774–1853), otherwise famous for his “Reise durch Norwegen und Lappland” from 1810. In 1847 von Buch described a new brachiopod species in the collection, *Spirifer Keilhavii*, in addition to two other spiriferids (Figure 4). He also mentioned one bryozoan species in the text,<sup>2</sup> *Fenestella antiqua* Lonsdale 1839. Based on the brachiopods, von Buch correlated the investigated rocks with the Carboniferous “Bergkalk”. Von Buch’s material is now in the Humbolt Museum in Berlin, whereas some specimens collected by Keilhau are in the palaeontological collection of the Natural History Museum, University of Oslo.

Laurent Guillaume de Koninck (1809–1887), Belgian chemist and invertebrate palaeontologist, identified material collected during the 1838–40 “Recherche” expedition to Svalbard.<sup>3</sup> He discussed (but did not illustrate) several species of the brachiopod genera *Productus* and *Spirifer* as well as some bryozoans: *Fenestella* [? *Acanthocladia*] *anceps* Schlotheim 1820, *Fenestella retiformis* Schlotheim 1820, *Stenopora tasmaniensis* Lonsdale 1844 and *S. ovata* Lonsdale 1844 in his 1847 publication. Based on the brachiopods and the bryozoans, de Koninck concluded with a Permian age for the investigated material, implying the existence of Permian rocks on Svalbard.

Skizze over Öerne i Polarhavet nordenfor Finmarken.

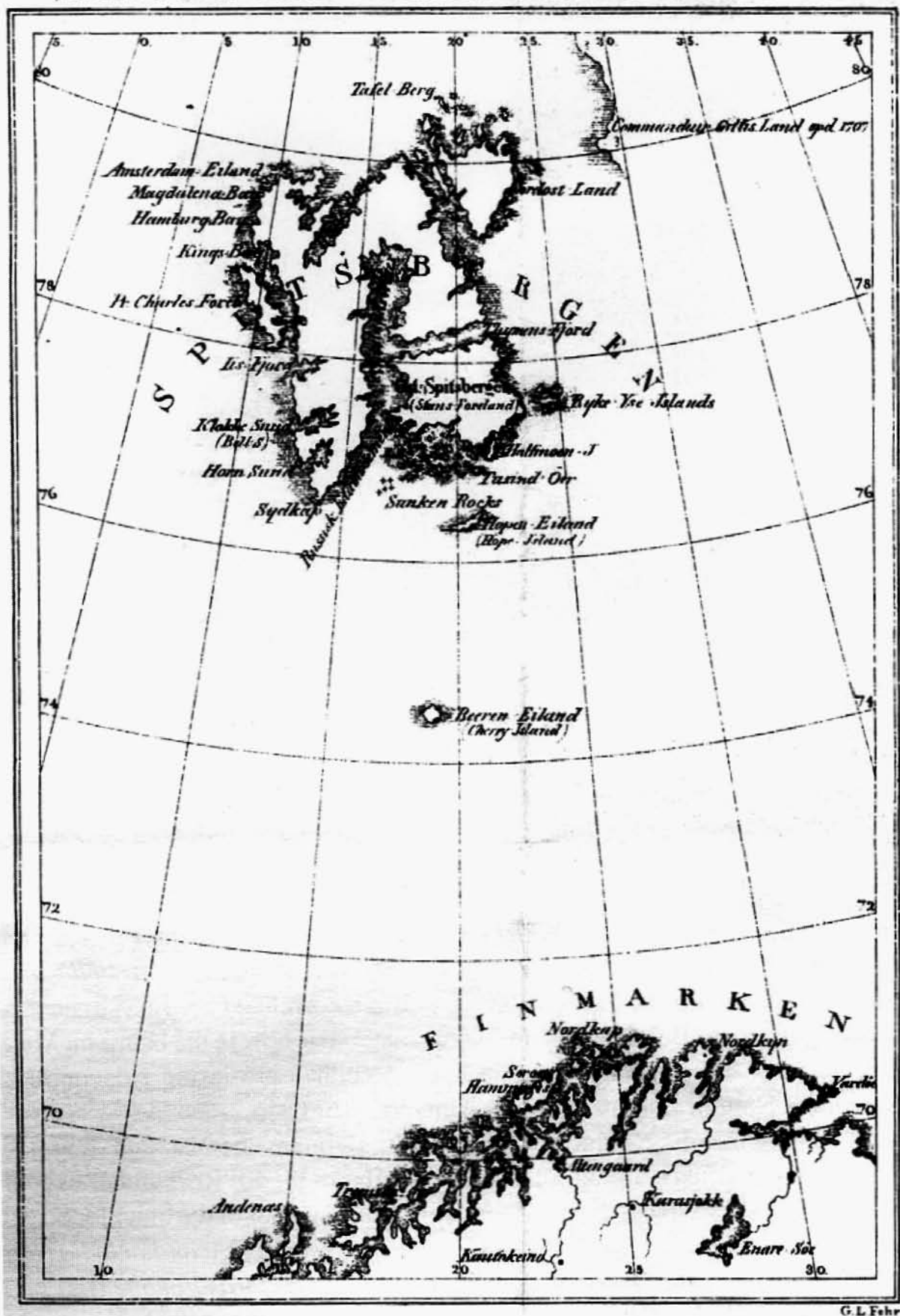


Figure 3. Map of northern Norway and Svalbard, as used by Keilhau in 1827.<sup>7</sup>

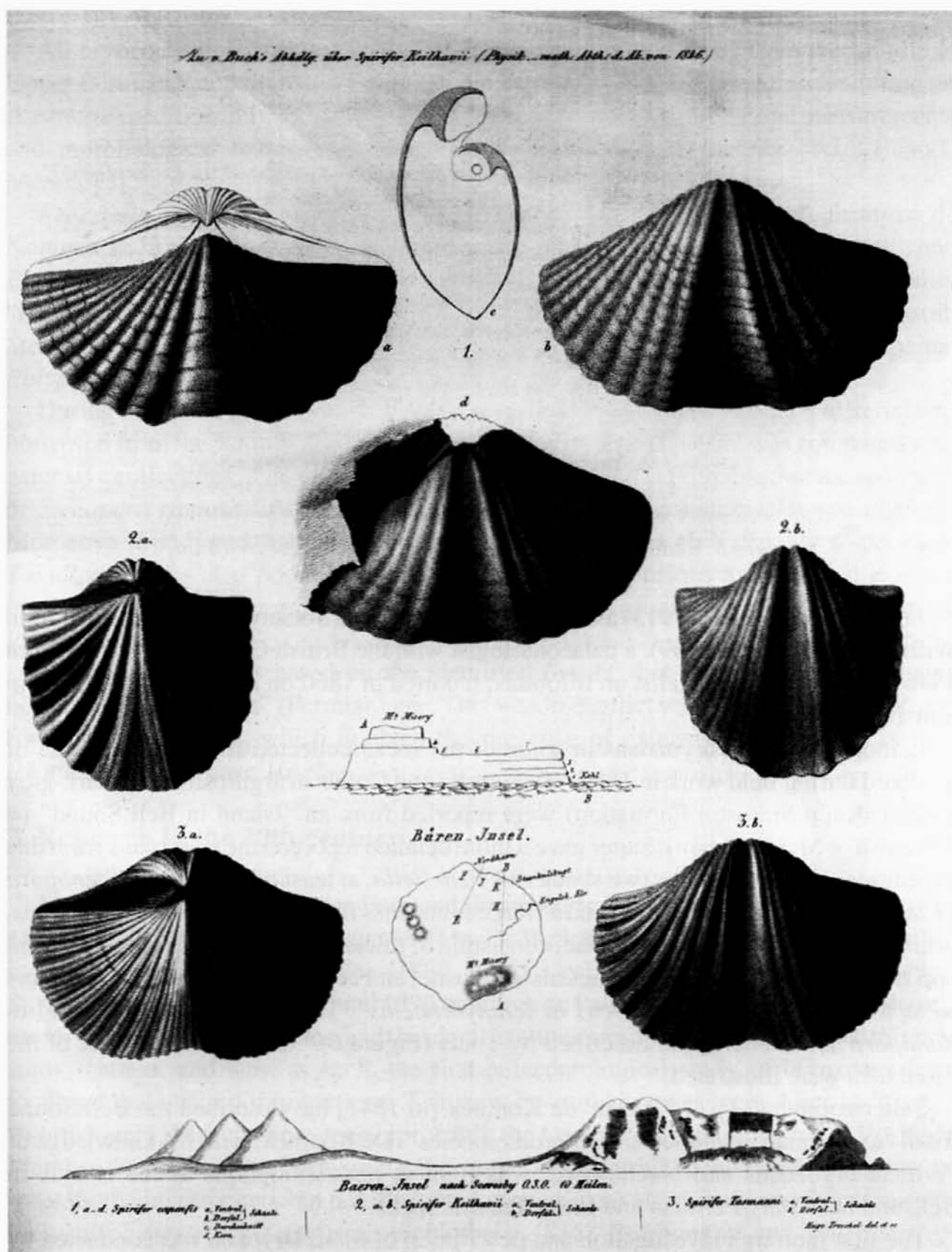


Figure 4. Plate showing brachiopods described by von Buch.<sup>8</sup>



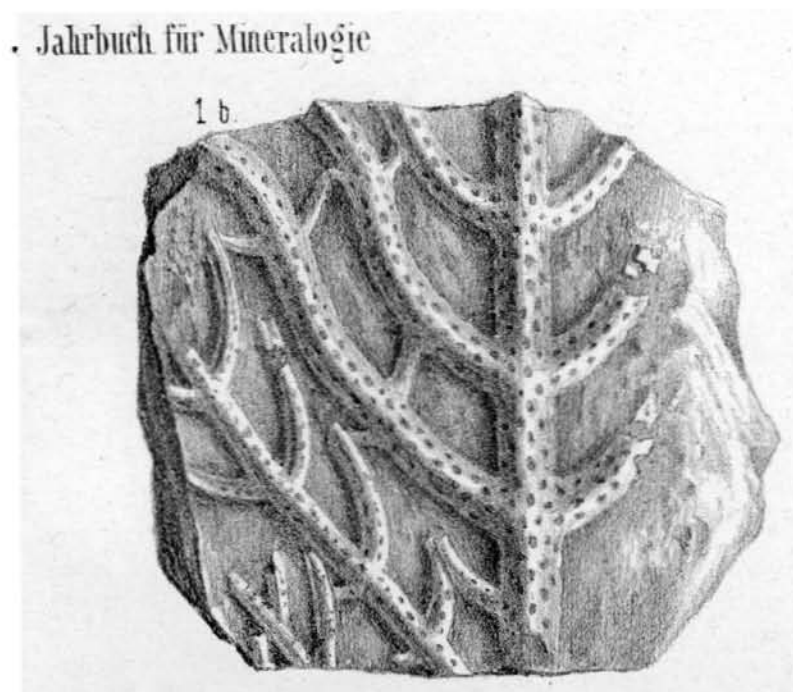


Figure 5. *Ramipora hochstetteri*, drawing of holotype by Toula.<sup>9</sup>

James Lamont (1828–1913) a Fellow of the Geological Society (of London), and John William Salter (1820–1869), a palaeontologist with the British Geological Survey from 1846 to 1863, and a specialist on trilobites, reported in 1860 on Palaeozoic fossils from Spitsbergen.<sup>4,5</sup>

Lamont discussed bryozoans in some of the rocks collected from various parts of Svalbard during field work in 1859. “*Fenestella* and Corals in argillosiliceous dark-grey rock” (=Kapp Starostin Formation) were reported from an “Island in Bell Sound” (= Akseløya or Mariaholmen). Salter gave a more detailed report on the bryozoans from this expedition. His list contains two species of *Fenestella*, at least one species of *Stenopora* (*S. tasmaniensis* Lonsdale 1844) and a “large foliaceous flattened species”, “a new genus, in all probability of the Fenestellidae, consisting of thick stems branching regularly from opposite sides, the smaller branches also opposite, and coalescing with their neighbours so as to be a gigantic *Thamniscus* or *Ichthyorhachis*”. The latter may be identical to *Ramipora hochstetteri* later described by Toula (Figure 5).<sup>6</sup> Unfortunately, none of the listed taxa were illustrated.

Salter comments (p. 440) that “de Koninck [in 1847] has described the Bell Sound fossils as Permian, and not Carboniferous species”. De Koninck, with his knowledge of Permian bryozoans and brachiopods, was right in his assumptions as the islands in Bellsund have only Permian and Early Triassic rocks.

The first thorough investigation and description of fossil Bryozoa was conducted by Franz Toula (1845–1920). Through the years 1873–1875 he published three papers on “Permo-Carbon-Fossilien” from southern and western Spitsbergen, and he described many new species. He was a student of Ferdinand Hochstetter, and he defended his doctorate on “Kohlenkalk-Fossilien von der Südspitze von Spitzbergen” in 1873 at the

University of Rostok, Austria.

All bryozoans described by Toula<sup>10</sup> are considered to be derived from the Middle to Upper Permian Kapp Starostin Formation, collected by Richard von Drasche during an Austrian expedition in 1873. Toula's identifications were based on external measurements and morphological features. Six taxa were identified from locality "Axel-Eiland" [Akseløya]:

*Fenestella* sp., *Polypora* cf. *dendroides* M'Coy 1844, *Polypora* cf. *fastousa* de Koninck 1873, *Polypora grandis* sp. nov., *Ramipora hochstetteri* gen. & sp. nov., and *Phyllopora laubei* sp. nov. *Stenopora ramosa* Geinitz 1861 was identified from locality "Arena/Galleri" [Kapitol/Trollfuglfjella], and four taxa from locality Kapp Starostin: *Stenopora ramosa* Geinitz 1861, *Stenopora tuberosa* Geinitz 1861, *Fenestella* sp. and *Polypora* sp.

During a revision of *Ramipora* done by Nakrem and Spjeldnæs<sup>11</sup> Toula's material was borrowed from the Naturhistorisches Museum (Wien). This material was compared with extensive collections of new material from Svalbard, and it is probable that the specimen of *Stenopora ramosa* figured as pl. X, fig. 2 is conspecific with *Cyclotrypa distincta* Morozova 1986,<sup>12</sup> and that the specimen figured by Toula as pl. X, fig. 3 is a species of *Tabulipora*. It is also possible, based on measured dimensions and detailed external observations, that *Reteporidra grandis* Morozova 1970 is a junior synonym of *Phyllopora laubei* Toula.

Toula concluded, as based on the identified fossils, that some of the investigated horizons were of "Dyas" [Permian] age. This was in conflict with some earlier work, e.g. Swedish descriptions, which doubted the presence of extensive Permian rocks here (Nordenskiöld on page 16).<sup>13</sup>

### 3. Research in the 20th century

Material from Prince Charles Foreland [Prins Karls Forland] was collected during an expedition to Svalbard in 1906 and 1907 by Dr W.S. Bruce, and subsequently described in 1908 by Gabriel Wharton Lee (1880–1928) a palaeontologist with the Geological Survey in Scotland.<sup>14</sup> From around 1890, research on Palaeozoic bryozoans started to rely more on the use of thin sections, and the identifications presented by Lee followed this new study method, and was, as such, the first palaeontological study of bryozoans from Svalbard that utilized thin sections. Two new bryozoan species were described from a "whitish-grey siliceous limestone" [probably the Lower Permian (Kungurian) Vøringen Member, Kapp Starostin Formation]: *Stenopora cidariformis* sp. nov. and *Stenopora* sp. indet. Some investigated, but not illustrated species were also mentioned from the same rock unit: *Fenestella* cf. *retiformis* (Schlotheim 1816), *Polypora* sp. and ?*Ramipora* sp. A new species was described from "a black fossiliferous limestone, hard and crystalline, and containing an abundance of carbonaceous matter" [possibly from the upper part of the Kapp Starostin Formation], "*Stenopora brucei* sp. nov. In addition to the bryozoans, Lee described many brachiopods, and concluded with an Artinskian (Early Permian) age for

the "black limestone", whereas other samples had a strong affinity with the German and British Zechstein (Late Permian).

Olaf Høltedahl (1885–1975), professor in geology at the University of Oslo between 1920 and 1955, published occurrences of bryozoans in the Lower Permian of western Spitsbergen in 1911<sup>15</sup> and 1913.<sup>16</sup> The material was collected during a Norwegian expedition to Spitsbergen 1909–1910 led by Gunnar Isachsen. Høltedahl's identifications were based on external characters.

Bryozoans were collected from the Asselian "Fusulina Limestone" [Brucebyen Bed, Tyrrellfjellet Member, Wordiekammen Formation], locality Scheteligfjellet: *Fenestella elegantissima* Stuckenberg 1895, *Fenestella* sp., *Pinnatopora tenuis* Eichwald 1850, *Ascopora nodosa* Fischer 1837, and *Coscinium sellaeforme* Trautschold 1879. Bryozoans associated with the "Fusulina Limestone" were reported from localities west of Grønnfjorden (Kongressdalen): *Fenestella plebeia* M'Coy 1844. This specimen has been thin sectioned, and re-identified as *Fenestella tricola* Trizna 1939 originally described from the Sakmarian - Artinskian of the Russian Platform, and *Pinnatopora* sp. Slightly above the "Fusulina Limestone": *Stenopora*(?) *romanowskyi* Stuckenberg 1895, and fragmentary *Fenestella* sp., *Polypora* sp., *Archimedes* sp. and *Rhombopora* sp.

Bryozoans and fusulinids in the two papers by Høltedahl were correlated with similar faunas in the "Schwagerina Horizon" of the Urals, at that time considered to be of Late Carboniferous age. Høltedahl's sampled intervals have later proved to be of Early Permian Asselian age.

Until Svalbard was awarded to Norway under the Spitsbergen Treaty signed on 9th February 1920, a number of different countries (e.g. Russia, Sweden) claimed land and undertook "occupations" there. Countries that signed the treaty could still undertake scientific and commercial activities in Svalbard, and for years, Russian settlements have mined Carboniferous and Tertiary coals, and in recent years they have also drilled for oil.

In July 1921 a Russian expedition with the vessel S/S "Koupava", led by D.M. Ivanov from Arkhangel'sk approached Bjørnøya. Nikolai Nikolaevitch Yakovlev was a member of the expedition, and their object was to explore some 5000 tons of Devonian coal. Horn and Orvin<sup>17</sup> wrote that "it is most possible that the real intention was to claim the island for Russia". A Norwegian mining establishment was however already there (Tunheim), to the Russians' great surprise. The Norwegian authorities did not allow the Russians access to the coal-bearing localities, and instead they collected Devonian plant fossils and some Permian marine fossils from Miseryfjellet and Sørhamna.

Pavel Ivanovitch Stepanov<sup>18</sup> reported in Yakovlev<sup>19</sup> the following bryozoans from the "Spirifer Limestone" [Miseryfjellet Formation] near Sørhamna and at Miseryfjellet: *Ramipora* sp., *Fenestella veneris* Fischer 1837, *Fenestella plebeia* M'Coy 1844, *Fenestella* aff. *geinitzi* d'Orbigny 1849, *Fenestella virgosa* Eichwald 1860, *Polypora orbicribata* Keyserling 1846, *Polypora goldfussi* Eichwald 1860, *Pinnatopora* cf. *grandis* M'Coy 1844, *Synocladia virgulacea* Phillips 1829, *Geinitzella columnaris* Schlotheim 1816, and *Coscinium dichotomum* Stuckenberg 1895. Recent investigations by the author on the Bjørnøya fauna from the Miseryfjellet Formation have revealed numerous specimens of



*Timanodictya nikiforova* Morozova 1966, and the specimen identified here by Stepanov as *C. dichotomum* is considered to be *Timanodictya nikiforova* Morozova 1966.

The bryozoans listed (not illustrated) by Stepanov have an Early Carboniferous to Late Permian distribution elsewhere. They were compared to and found to resemble bryozoan faunas from the "Schwagerina Horizon" of Northern Timan (Asselian), but also showing similarities with younger faunas (e.g. Late Permian Zechstein species).

The second study of Permian bryozoans from Svalbard using "modern" bryozoan techniques (i.e. studying and illustrating internal characters in thin sections) was published by Alexandra Ivanovna Nikiforova (1894–1939) of the Geological Committee and VNIGRI, St. Petersburg, in 1936.<sup>20</sup> Bryozoans in this publication were collected from locality Kongressdalen, through the upper part of the Kapp Starostin Formation. Nine bryozoan taxa were described, including four new species and one new subspecies: *Fenestella* sp. ex gr. *basloensis* Bassler 1929 var. *magna* Forma A Shul'ga-Nesterenko 1936, *Fenestella foraminosaeformis* Shul'ga-Nesterenko 1936, *Fenestella greenharbourensis* sp. nov., *Fenestella* aff. *pulcherrima* Shul'ga-Nesterenko 1936, *Fenestella spitzbergenensis* sp. nov., *Polypora reteporidraeformis* sp. nov., *Polypora timorensis* Bassler 1929 var. *greenharbourensis* subsp. nov., *Ptylopora* sp., *Septopora synocladiaformis* sp. nov., and *Ramipora hochstetteri* Toula 1875.

Bryozoans from Novaya Zemlya (Arctic Russia) were described in the same paper, and the faunas were compared. Although the Novaya Zemlya fossils were badly preserved, resemblances were pointed out. The faunas were also compared with Early Permian faunas at that time known from the Urals, and the "Productus Chert Series" of the upper part of the Kapp Starostin Formation was proposed to be of Artinskian age. Morozova and Kruchinina<sup>21</sup> revised the material first described by Nikiforova, and placed the fauna to a correct Middle to Late Permian age. The new fenestellid species were transferred to new genera: *Alternifenestella greenharbourensis* (Nikiforova 1936), *Alternifenestella spitzbergenensis* (Nikiforova 1936), *Polypora reteporidraeformis* Nikiforova 1936 sp. nov., and *Polyporella greenharbourensis* (Nikiforova 1936). Nikiforova's specimen of *Ramipora hochstetteri* Toula 1875 (pl. 2, figs. 7–10) was subsequently made holotype for the new species *Ramipora lepida* Morozova,<sup>22</sup> but see discussion by Nakrem and Spjeldnæs.<sup>23</sup>

Until new systematic descriptions of bryozoans appeared in the 1960s, only lists of faunas, with no illustrations appeared in general palaeontological works. Forbes, Harland and Hughes<sup>24</sup> presented lists of bryozoans (identified by T.G. Miller of Keele University) appearing in the uppermost Carboniferous "Lower Wordiekammen Limestone" (=Lower part of the Cadellfjellet Member, Wordiekammen Formation) (six taxa), "Upper Wordiekammen Limestones" (Tyrrellfjellet Member, Wordiekammen Formation) (five taxa) and from the upper part of the Kapp Starostin Formation (thirteen fenestellid taxa). Due to incomplete understanding of Late Permian stratigraphy and bryozoan distribution, their lists contain almost exclusively Late Carboniferous through Early Permian taxa, even for the Middle to Late Permian Kapp Starostin Formation.

Beginning in the 1950s, Polish work under the leadership of Stanislaw Siedlecki and

later Krzysztof Birkenmajer led to a rich series of publications, many of them from southern Spitsbergen and the area around the Polish research station in Hornsund. The first report on bryozoans was presented by Stanislaw Czarniecki in 1964.<sup>25</sup> Fossils were collected from the fossiliferous "Coral Horizon IV" within the "Treskelodden Beds" (=Treskelodden Formation), inner Hornsund, Burgerbukta. The age of these beds is earliest Permian. He described a single bryozoan, *Archimedes* aff. *magnus* Condra and Elias, 1944. *A. magnus* has a Chesterian (Early Carboniferous) distribution in North America.

Material collected during the Polish expeditions was investigated by Jerzy Malecki in two papers in 1968<sup>26</sup> and 1977.<sup>27</sup> He presented the first illustrated description of Permian bryozoans from Svalbard using modern (thin section) methods after Nikiforova's pioneer work in 1936. The stratigraphy of the investigated strata was now also better understood, after Cutbill and Challinor in 1965 revised the stratigraphical scheme for the Carboniferous and Permian rocks of Spitsbergen and Bjørnøya<sup>28</sup> (see Figures 6 and 7 for old and current stratigraphic units used there).

Malecki<sup>29</sup> described six taxa, including one new species: *Tabulipora siedleckii* sp. nov. and *Stenopora dickinsi* Ross 1963 from the Tokrossøya Formation (Middle to Late Permian) of southern Spitsbergen, *Polypora* sp. cf. *russiensis* Shul'ga-Nesterenko 1941, *Ramipora* cf. *hochstetteri* Toulou 1875, *Fenestella* sp. and *Fenestella* (*Septopora*) sp., from the Miseryfjellet Formation (Middle to Late Permian) of Bjørnøya.

In 1977 Malecki<sup>30</sup> subsequently described nine taxa including two new species: *Hinganella heintzi* sp. nov., *Stenopora dickinsi* Ross 1963, *Stenopora jungersenensis* Ross and Ross 1962, *Tabulipora greenlandensis* Ross and Ross 1962, *Rhombotrypella* cf. *composita* Nikiforova 1939, *Dyscritella bogatensis* Morozova 1970, *Septopora phyllata* sp. nov. and *Timanodictya nikiforovae* Morozova 1966 from the Miseryfjellet Formation of Bjørnøya; *Stenopora jungersenensis* Ross and Ross 1962 and *Tabulipora greenlandensis* Ross and Ross 1962 from the Kapp Starostin Formation of western Spitsbergen; *Rhombotrypella* cf. *gigantea* Ross and Ross 1962 from the Tokrossøya Formation of southern Spitsbergen, and *Streblascopora* (*Streblotrypa*) *fasciculata* Bassler 1929 from the Reinodden/Treskelodden Formation of southern Spitsbergen (not Miseryfjellet Formation as stated in the publication).

In a revision from 1988 of Malecki's works, Nakrem<sup>31</sup> demonstrated after extensive field work in Svalbard and after the publication of "Permian bryozoans of the Arctic" by Morozova and Kruchinina<sup>32</sup> that *Hinganella heintzi* Malecki 1977 should be placed in the genus *Gilmoropora* Morozova in Morozova and Kruchinina,<sup>33</sup> and also become the type species of this monospecific genus. *Gilmoropora heintzi* (Malecki) has so far not been found outside Bjørnøya. *Septopora phyllata* Malecki 1977 was only described from external features observed in a single specimen. In a revision of *Ramipora* by Nakrem and Spjeldnæs<sup>34</sup> Malecki's specimen was investigated, and it became clear that his specimen is conspecific with *Ramipora hochstetteri* Toulou 1875, a common species in the Middle to Upper Permian of Svalbard.

In 1970 Birkenmajer, Fedorowski and Smulikowski published a provenance study<sup>35</sup>

Older nomenclature		Dallmann (ed.), 1999		
Prductusführende Kieselgesteine / Brachiopod Cherts		Kapp Starostin Fm.	Tokross- øya Fm.	
Spiriferenkalk		Vøringen Mbr.		Permian
Upper Gypsiferous Series		Gipshuken Fm.		
Cyathophyllum- kalk	Fusulina Limestone	Tyrrellfjellet Mbr. Wordie- kammen Fm.	Treskel- odden Fm.	Carboniferous
Bergkalk		Kapitol/Cadellfjellet Mbr.		
	Minkinfjellet Mbr.	Minkinfjellet Fm.	Hyrne- fjellet Fm.	
	Nordenskiöldbreen Fm.			

Figure 6. Stratigraphic units, old and current, of Central-Western and Southern Spitsbergen.<sup>36</sup>

Older nomenclature		Worsley et al., 2001		
Spirifer Limestone	Oberkarbon	Miseryfjellet Fm.	Tempelfjorden Group	
Cora Limestone		Hambergfjellet Fm.	Bjarne- land Grp.	Permian
Fusulina Limestone		Kapp Dunér Fm.	Gipsdalen Group	Carboniferous
Yellow Sandstone		Kapp Hanna Fm.		

Figure 7. Stratigraphic units, old and current, of Bjørnøya.<sup>37, 38</sup>

and an analysis of pebbles in the Tertiary Gilsonryggen Formation. Fossils were present among the pebbles. Some bryozoans (identified by I.P. Morozova, and discussed by J. Fedorowski in the publication) were found, believed to derive from the Carboniferous-Permian strata: *Fenestella* sp., *Rhabdomeson* sp., and *Goniocladia* sp.

Lazutkina and Goryunova described in 1972 new species of Permian bryozoans from the Vøringen Member of the Kapp Starostin Formation.<sup>39</sup> Their two species, *Septopora spitzbergensis* Lazutkina sp. nov. and *Tabulipora greenlandensisiformis* Lazutkina sp. nov. are not found outside Svalbard.

#### 4. Recent years

The extensive publication "Permian bryozoans of the Arctic" by Iraida Pavlovna Morozova and Olga Nikolaevna Kruchinina from 1986<sup>40</sup> contains revisions and description of new material from the Permian of Arctic Canada, Svalbard, Novaya Zemlya (Arctic Russia) and Timan-Pechora (Western Siberia, Russia). The Svalbard material in this publication was collected through the Tempelfjorden Group (Miseryfjellet Formation of Bjørnøya and Kapp Starostin Formation of Spitsbergen), and an Ufimian age was concluded for the fauna investigated.

Thirteen taxa were described from the Kapp Starostin Formation (Spitsbergen) including the following new species (all attributed to Morozova as author): *Ramipora lepida* sp. nov. (holotype from the Kapp Starostin Formation, Spitsbergen, but see discussion<sup>41</sup>), and *Lyrocladia vera* sp. nov. Sixteen taxa were described from the Miseryfjellet Formation (Bjørnøya), including the following new species: *Cyclotrypa eximia* sp. nov., *Cyclotrypa distincta* sp. nov., *Tabulipora aberrans* sp. nov., *Rhombotrypella alfredensis* sp. nov., *Dyscritella lucida* sp. nov., *Dyscritella minuta* sp. nov., *Dyscritella maleckii* sp. nov., *Dyscritellina fuglensis* sp. nov., *Dyscritellina arctica* sp. nov., *Rectifenestella logica* sp. nov., *Polyporella optima* sp. nov., *Wjatkella assueta* sp. nov., *Reteporidra tuncheimensis* sp. nov., *Gilmoropora unica* gen. & sp. nov.

Revisions<sup>42-43</sup>: *Ramipora lepida* Morozova 1986 = *Ramipora hochstetteri* Toulou 1875 and *Gilmoropora unica* Morozova 1986 = *Gilmoropora heintzi* (Malecki 1977).

In 1985 the current author started a detailed study of Carboniferous, Permian and Triassic bryozoans from Svalbard under the "Arctic Geoprogram", led by (then) IKU Petroleum Research, Trondheim, Norway. The study of bryozoans was accompanied by studies of fusulinids, conodonts and palynomorphs from the same stratigraphic units.

In 1988 Nakrem<sup>44</sup> presented a revision of bryozoans described by Malecki in 1968<sup>44</sup> and 1977.<sup>46</sup> The main re-assignment is the revision of *Hinganella heintzi* Malecki 1977. Morozova<sup>47</sup> erected the new genus *Gilmoropora* based on material only from Bjørnøya. It seems likely that this material is similar to that investigated by Malecki, and that the type species by Morozova *Gilmoropora unica* is conspecific with Malecki's type material. Thus, the only species known so far should correctly be named *Gilmoropora heintzi* (Malecki 1977). The paper also contains a revision of *Septopora phyllata* Malecki 1977 which is conspecific with *Ramipora hochstetteri* Toulou 1875.



A preliminary report on the distribution of bryozoans through the uppermost Carboniferous and Permian of Svalbard was presented by Nakrem in 1991.<sup>48</sup> No new species were erected, and no bryozoan illustrations were presented. Five species are listed from the uppermost Carboniferous, eleven species from the Lower Permian (Asselian-Sakmarian), thirteen taxa from the Artinskian-Kungurian, and fifteen taxa from the Middle to Upper Permian of Spitsbergen. Two species are reported from the Asselian, six from the Artinskian and fifteen from the Middle to Upper Permian of Bjørnøya.

Triassic bryozoans from Spitsbergen have been known since the 1950s (Thore Winsnes, Norsk Polarinstitutt, pers. comm. 1988), but remained absent in the literature until short reports by Worsley and Mørk<sup>49</sup> and Mørk, Knarud and Worsley.<sup>50</sup> In 1977, David Worsley (then of the Palaeontological Museum, University of Oslo) and Atle Mørk (IKU/SINTEF Petroleum Research) located a rich bryozoan-bearing bed in the Bjørnskardet section (Sørkapp Land) and Treskelen section (Hornsund). The latter section was recollected in 1982 by Worsley, and during the Norsk Polarinstitutt 1988 expedition, T. Winsnes collected additional samples at Kovalevskifjellet. In 1988, the author collected Triassic and Permian bryozoans from Akseløya and Mariaholmen (Bellsund). Analysis of the mentioned material led to the description of new species by Nakrem and Mørk<sup>51</sup> (attributed to Nakrem as author): *Paralioclema winsnesi* sp. nov., *Paralioclema mariaholmensis* sp. nov. and *Paralioclema* sp. cf. *mariaholmensis*. *Paralioclema winsnesi* was subsequently transferred to the genus *Arcticopora* by Nakrem and Ernst.<sup>52</sup>

Nakrem, Nilsson and Mangerud presented the distribution of biostratigraphically relevant fossil groups through the Permian of Svalbard.<sup>53</sup> Bryozoans are mentioned in range charts, but with no bryozoan descriptions or illustrations.

During a joint research programme between the Norwegian Polar Institute and a Japanese group of geologists (Hokkaido University, Sapporo), bryozoan material was collected from several Permian outcrops. An extensive fauna from the Kapp Starostin Formation was described and illustrated, and Sumio Sakagami's collection contains six taxa from the Artinskian-Kungurian, and thirty-eight taxa from the Middle to Upper Permian.<sup>54</sup>

An extensive bryozoan fauna occurring through the Gipsdalen Group (Upper Carboniferous–Lower Permian) of Svalbard (excluding Bjørnøya) was presented by Nakrem in 1994.<sup>55</sup> Thirty-six taxa were described and illustrated from this Late Carboniferous (Moscovian)–Early Permian (Artinskian) unit. The author pointed out the biostratigraphical value of the investigated faunas, and discussed distinct similarities with contemporaneous units in the Urals and Timan-Pechora (western Siberia). One species was considered new, *Hinaclema svalbardensis* sp. nov. from the upper part of the evaporitic Gipshuken Formation. This species may, however, not belong to *Hinaclema* (Gorjunova, pers. comm. 1997).

The next paper by Nakrem published in the same year<sup>56</sup> described growth forms versus depositional environment (mainly current energy). Five taxa were illustrated from the Kapp Starostin Formation, and a single taxon, ?*Hinaclema* sp. from the upper part of the evaporitic Artinskian Gipshuken Formation.

An extensive description of bryozoans through the Artinskian-Kungurian Vøringen Member (basal member of the Kapp Starostin Formation) was published in Nakrem in 1995.<sup>57</sup> Forty taxa were described and illustrated, among them four new species: *Fenestella akselensis* sp. nov., *Fenestella reversicnotta* sp. nov., *Lyropora serissima* sp. nov., and *Meekopora magnusi* sp. nov. The author pointed out the biostratigraphical value of the investigated faunas, and outlined distinct similarities with contemporaneous units of North Greenland, the Urals and Timan-Pechora (western Siberia).

Nakrem and Spjeldnæs<sup>58</sup> presented a revision of the goniocladiid genus *Ramipora* Toula based on new material collected from the type horizon (Kapp Starostin Formation, Akseløya) and elsewhere in the Svalbard Archipelago, and also on Toula's type specimen.

Fieldwork in the 1990s revealed a bryozoan buildup in the Upper Carboniferous Minkinfjellet Formation at locality Nordströmfjellet (Gipsdalen, Spitsbergen). The bryozoans and the ecology of this buildup were reported by Nakrem in 2002,<sup>59</sup> and 18 bryozoan taxa were listed and partly illustrated. A possible new genus remains undescribed ("*Ptylopora*" sp. A). The buildup also possibly contains the first observed encrusting cyclostomatous bryozoan *Hederella*, from Svalbard. Eight bryozoan species are reported from directly above the buildup.

Since exploration for petroleum in the Barents Shelf started in the 1980s, numerous wells have been drilled. Upper Palaeozoic and Mesozoic rocks have been the target for these exploration activities. Marine carbonates and shales have been penetrated by shallow drilling cores, and many of these contain numerous bryozoans with strong similarities to the faunas known from Svalbard. Work is still in progress to describe these faunas, and although many papers mention and illustrate bryozoans in drilled intervals (e.g. Blendinger and co-authors in 1997<sup>60</sup>), only a preliminary abstract on the bryozoan occurrences has been published by Nakrem in 1997.<sup>61</sup>

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## Notes

Taxonomic lists can be found on the Natural History Museum (Oslo) web pages.

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