NOTES ON THE ORDOVICIAN FOSSILS FROM BEAR ISLAND COLLECTED DURING THE SWEDISH EXPEDITIONS OF 1898 AND 1899

BY

OLAF HOLTEDAHL

During his Arctic Expedition in the summer of 1898 A. G. NATHORST[1] succeeded in finding fossils in a limestone of the socalled Heclahook-system of Bear Island, the small inlet lying isolated between Norway and Spitzbergen, at about 74 1/2 ° N. L. (see map p. 91). This Heclahook-system consists of a series of limestone, dolomite, quartzitic sandstone and shale, folded and generally very much pressed, found by A. E. NORDENSKIÖLD during his visits in 1864 and 1868 to be very similar to the sedimentary series of Spitzbergen, that by him was given the name of Heclahook after a locality on the north coast.

The fossils were few and very fragmentary, cephalopods being the most abundant. They were given to G. LINDSTRÖM for further investigation, and the results appeared in a paper „On a species of Tetradium from Beeren Eiland"[2]. While the other fossils found, *Actinoceras* sp., a strophomenoid brachiopod and fragments of crinoidal stems were found insufficient to date the horizon, the occurrence of a *Tetradium* proved the Ordovician

[1] NATHORST: Några upplysningar till den nya kartan öfver Beeren Eiland. Ymer, 19, Stockholm 1899, p. 181.

[2] Öfversigt Kgl. Sv. Vet. Akad. Förh., 56, 1899, p. 41.

age of the fauna. As to the more exact age LINDSTRÖM says (p. 46): „It is consequently at present only possible to restrict the age of the Beeren Eiland limestone with *Tetradium* within the limits of the Trenton and Hudson groups or of the Trinucleus shale and Leptæna limestone groups of Sweden. The more precise statement of its equivalence must be reserved until richer paleontological evidence has been received".

During the summer 1899 J. G. ANDERSSON stayed a couple of months in the island, studying in detail the stratigraphical and tectonical features. He collected more fossils in the „Tetradium limestone" (which is considered the oldest stratigraphical member of the „Heclahook" of the island), yet without finding much that was new. In his papers[1] treating the geology of the Bear Island are mentioned the following fossils from the said limestone: *Actinoceras*, several species, fragments of crinoid stems, *Strophomena* sp., bryozoa, *Tetradium* sp.

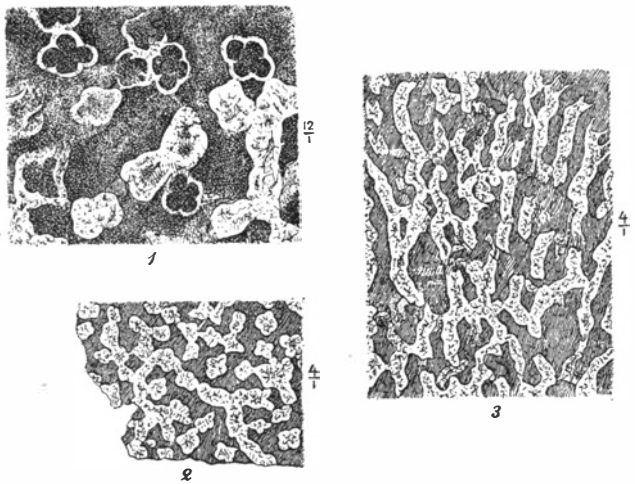
During the later years of his work on the geology of northern regions the present writer on several occasions felt the want of exact knowledge as to the age and paleontological character of the fauna of the Tetradium limestone of the Bear Island, this fauna being the only one known from Ordovician time in a huge northern district. What seemed to make the fauna especially interesting was the distinct American character that was fairly evident only from the data that was known. The typical American character of a genus like *Tetradium* was emphasized already by LINDSTRÖM, the occurrence of *Actinoceras* together with it, while no trilobite was found, strongly supported the view.

Through the kindness of Professor G. HOLM, director of the zoo-paleontological department of the Swedish State Museum (Riksmuseet) I have on request received as a loan the material for a revised study, the results of which are given below.

As was well known before, the preservation of the fossils is very bad, as they occur in a rock — a dark grey, compact

[1] Se Bull. Geol. Instit. of Upsala, 1899, and Geol. Föreningen i Stockholms Förh. 23, 1901.

limestone — that has suffered very much from pressure. The fossils therefore are deformed in all sorts of manners. The limestone is furthermore full of fractures making any attempt at working out the fossils of the rock almost impossible.



LINDSTRÖMS illustrations of *Tetradium* sp. from Bear Island.

Anthozoa.

Tetradium cf. *syringoporoides* ULRICH.

Pl. IX, fig. 2—3.

The *Tetradium* species which is seen in a large number of specimens, has been closely examined by LINDSTRÖM, who has given a detailed description of the form besides illustrations, reproduced here. The general characters of the species from Bear Island will be got from the illustrations and from LINDSTRÖMS description of which the following lines give a good idea as to the general form of the fossil (l. c. p. 42): „the Beeren Eiland specimens form a loosely coherent, rather spongy mass, the tubes having grown isolated, only united laterally through horizontal tubuli or stolons in the same manner as the Syringoporæ with which corals they thus have a slight resemblance. Seen from the superior surface again there is

something reminding of Halysites in the chains of coherent tubes as shown in the subjoined figures".

While none of the forms of *Tetradium* which were described at the time when LINDSTRÖM made his studies showed any very close likeness to the species from Bear Island there has been described in more recent years a form that without doubt comes very near to it. This is the *Tetradium syringoporoides* ULRICH, mentioned by the said author from the Ordovician of Pennsylvania in the U. S. Geol. Surv. Folio 170, 1910, p. 58 in the following words: „the single-tubed form of this genus so characteristic of the Stones River". A photograph of a slab of limestone from the upper portion of the Stones River of Virginia with this species was reproduced by BASSLER in Bulletin II A, Virginia Geol. Surv., 1909, pl. IV, fig. 2, giving however no clear impression of the characters of the form. In very recent time *T. syringoporoides* has been cited by WILSON and MATHER from a more northern district of North America, viz. from the Kingston area at the eastern end of Lake Ontario[1].

In order to obtain more definite information of the form I have written Miss ALICE WILSON as to this matter and she has kindly answered, saying among other things about a slab with *T. syringoporoides*, found in the Pamelia beds at Clayton, N.Y.: „In it the tubes are about the size and arrangement of your drawing, sometimes scattered, sometimes united; the whole is in a general radiating from a centre. But, while the tubes themselves are about the size of those in your drawing, though frequently farther apart, the small transverse processes average greather length and not so large in diameter. I can hardly speak for their frequency because they are so poorly preserved that they are only in isolated pieces. In the specimen I have the tubes are not so sharp cornered as the usual Tetradium. This, however, may be due to the poor preservation".

Furthermore is given in the letter statement about a form considered a variety of *T. syringoporoides*, occurring in the

[1] Synopsis of the common Fossils of the Kingston Area, in Vol. XXV, Part III of Rep. Ontario Bureau of Mines, 1916.

Lowville limestone of Wolfe Island, showing more differing features.

At a later time I also wrote Dr. ULRICH about the specimens from Pennsylvania etc. but, probably owing to the late and uncertain postage have as yet got no answer.

Even if the exact relation of the *Tetradium* of the Bear Island to the true *T. syringoporoides* cannot as yet be said to be quite settled it is beyond doubt that the forms show very considerable likeness.

As to the horizon of the American species it belongs fairly low down in the Ordovician. The Pamelia is by KINDLE in the said Ontario publication placed in the lower part of the Black River, while ULRICH puts the zone in uppermost Stones River.

As LINDSTRÖM has especially emphasized, *Tetradium* is a typical American genus, well represented in North America while in Europe scarcely any species have been found[1]. BASSLER in his list of Ordovician fossils from the Baltic area[2] mentions a *Tetradium* sp. from the Borkholm. *Tetradium* is furthermore a typical Ordovician genus.

Bryozoa.

A large number of specimens of bryozoa are found in the collection but the structure is not so well preserved as to make any exact identification possible.

Some of the bryozoa have a branching growth, one species (figured pl. IX, fig. 4) having a very considerable size, another a diameter of only 2—3 mm. Further we have forms that have formed compact (probably hemispherical) masses, some of which have to some extent preserved their structure allowing, however, of no detailed study. Finally must be mentioned what probably must be a large bryozo, forming a thin irregularly semispherical rust, with greatest diameter 12 cm.

---

[1] The remarkable Baltic Ordovician fossil *Tetradium (Wrangeli)* SCHMIDT has nothing to do with *Tetradium* DANA, being probably related to *Conularia*.

[2] U. S., p . 19.Nat. Mus. Bull. 77, 1911

Crinoidea.

Fragments of crinoid stems are common in some of the rock specimens.

Brachiopoda.

Rafinesquina sp.

Pl. IX, fig. 1.

A small form the exact outline of which can not be seen. The width at hinge line seems to have been 14 mm., length 10 mm. Rather strongly curved at the marginal border, while the central disc is nearly flat. Surface ornamentation consists of radiating ribs of two sizes; they are except in the median portion, sligthly curving. Between each pair of stronger ribs come 2—4 finer ones. Also a contentric lineation, sometimes wrinkle-like can be seen.

Any attempt at full identification based on this single incomplete specimen would be without result.

Cephalopoda.

Orthoceras (Kionoceras?) sp.

Pl. XI, fig. 2.

A single broken specimen of a straight or nearly straight cephalopod, characterized by an ornamentation consisting of longitudinal ridges, which, though not much elevated, have a rather sharp section. In some places there seems to be present a faint ridge in the middle of the interval between the ridges and possibly an indication of other, extremely faint ones. The siphuncle is of medium size, somewhat but not very expressedly exentric and distinctly nummuloidal. Vertical distance of the septa about $^1/_5$ of the diameter of the shell.

According to the generic system of HYATT[1] the species ought to be included in *Kionoceras* HYATT (genotype *K. doricum* BARR.)

[1] Proc. Boston Society Nat. Hist. 22, 1884, p. 275.

characterized by longitudinal ridges. This genus is, however, known only from the Silurian, Devonian and Carboniferous. A somewhat similar genus is *Spyroceras* which is also known from the Ordovician, and where in the more adult stages of growth the shell is distinctly annulated.

The specimen shows some resemblance to the Silurian *Orthoceras (Kionoceras) angulatum* WAHL. (and *O. Bachus* BARR. which by FOORD[1] is regarded identical with *O. angulatum*). These are, however, distinctly curved forms.

Probably the specimen from Bear Island represents a new species but with only this single specimen at hand, and even that not well preserved I will refrain from going any more into the question. The occurrence of this type of a cephalopod in an undoubtedly Ordovician horizon is at any rate of interest.

Endoceras (Vaginoceras?) sp.

Pl. X, fig. 1.

Two pieces consisting of a compact mass of endosiphosheaths of only slightly tapering conical form.

In all probability the specimens represent a species of the subgenus *Vaginoceras* HYATT, where the very numerous endosiphosheaths are very characteristic. The two common American species of *Vaginoceras*, *V. longissimum* HALL and *V. multitubulatum* HALL are characteristic Black River fossils. A third one *V. oppletum* has been described by RUEDEMANN from the Chazy.

Endoceras sp.?

Pl. IX, fig. 5.

A fragment of a fairly thick cephalopod now oval in section, with annulations that are strongly deformed by pressure. In cross section an indication of a ring is seen, which, however, lies fairly close to the outer wall; if this ring marks the section of a siphuncle the latter must have been exeedingly large. In longitudinal section no further structure is seen.

[1] Catalogue of the Fossil Cephalopode in the British Museum I, 1888, p. 70.

Actinoceras Bigsbyi BRONN (*A. tenuifilum* HALL?).

Pl. X, fig. 2—3, pl. XI, fig. 1.

For references see BASSLER, Bull. 92, U. S. Nat. Mus., 1915, p. 11.

This is by far the commonest fossil in the collection, most of the specimens being, however, exeedingly fragmentary. Some are somewhat more complete, especially the one figured pl. X, fig. 3, and by putting together what may be seen from the different pieces a fairly good idea of the characters of the species is obtained.

The character that is of a especial interest for the identifying of the form, the size of the excentrically situated siphuncle in proportion to the entire thickness of the shell, can be fixed with certainty. In the earlier stages it is about $^2/_3$ of the entire width, in the adult stages about $^1/_2$.

Of the *Actinoceras* species that have been described there are two that come exeedingly near to the specimens from Bear Island, *A. Bigsbyi* BRONN and *A. tenuifilum* HALL. As far as I can see from the American literature (most distinctly expressed in the „North American Index Fossils" by GRABAU and SHIMER, p. 115), the chief distinguishing character of the two forms lies in the stronger concavity of the septa of *A. Bigsbyi.* If this very marked concavity is a constant character to be relied upon, there may be some doubt if the Arctic form, here mentioned, had not better been considered identical with *A. tenuifilum* HALL, as the concavity is not so very great. If this Arctic form, however, represents *A. tenuifilum* HALL it looks as if also others of the assumed *A. Bigsbyi*, referred to in BASSLERS references, ought to be placed under *A. tenuifilum*. The *Orthoceras Bigsbyi*, figured by BILLINGS in „Géologie du Canada" (1864), p. 158, fig. 107 has not at all very concave septa, not more so than the specimens from Bear Island.

So prominent a student of fossil nautiloids as FOORD strongly claims (Cat. Foss. Ceph. p. 168—169) that there can be no doubt about the identity of HALLS *Ormoceras tenuifilum* with the *Actinoceras Bigsbyi* BRONN. This then, is a question that has to be finally decided by American paleontologists.

Actinoceras Bigsbyi is a typical American species, being a very common fossil in the Black River throughout a vast district from Tennessee towards the north-north-west to Manitoba, further in New York, Ontario and Arctic America (Igloolik Isl. Fox Channel, 69° 20′ N. L.). *A. tenuifilum* is also known from the Black River, in Tennessee, Kentucky and New York.

Ordovician representativs of *Actinoceras* may be said to be characteristic of the American faunal province while in Silurian time, the genus has spread also to Europe and is quite commonly found in England and the Scandinavian-Baltic regions. The *Orthoceras laeve* SCHMIDT[1] is thought by EICHWALD (Lethæa Rossica, p. 1254) to be near *Actinoceras Bigsbyi*, and *A. Bigsbyi* BRONN aff. is mentioned by the same author (l. c. p. 1253) as occurring in the *Orthoceras* limestone in the vicinity of Wesenberg and Nyby in Estland. When looking through the fossil lists of the Baltic Ordovician, published in more recent time by LAMANSKY and BASSLER, no *Actinoceras* species is mentioned, so the question of the occurrence of this genus there thus seems a little uncertain. Of interest is the occurrence of a true *Actinoceras* (resembling somewhat the Silurian *A. imbricatum* HIS.) found in the uppermost Ordovician (stage 5) of some districts at the western side of the Kristiania region, in Hadeland and Ringerike. The form is here quite common. This may possibly indicate the approaching of the *Actinoceras* stock coming from the west or northwest, spreading in Silurian time all over southern Norway and Sweden.

Gonioceras (*occidentale* HALL?) sp.

Pl. XI, fig. 3.

For references see BASSLER, Bull. 92, U. S. Nat. Mus., p. 562.

This highly interesting form is represented by two fragmentary specimens.

[1] Archiv für die Naturkunde Livlands etc. Dorpat 1858, p. 195. — In „Revision d. ostbalt. sil. Trilobiten" I, Mem. L'Ac. Imp. Sc. Petersb. Ser. VII, XXX, I, 1881, SCHMIDT cites *Orthoceras laeve* from the zone B_3.

It is probably this form that was considered as one of the *Actinoceras* species, mentioned in J. G. ANDERSSON'S papers. In fact when first looking over the material also the writer, when seeing only the siphuncle and adjacent part of the septa of the two specimens, found it probable that the species represented some *Actinoceras* with very slender siphuncle. By getting a cross section of one of the specimens and grinding it it became, however, evident that the specimen even in a not pressed state must have been far from circular in section, and I was thus brought to think of the possibility of the form being a *Gonioceras*. A careful grinding of the peripheral part of the best preserved specimen proved this to be the fact.

Though none of the lateral flanges of the shell are fully preserved and the character of the septa cannot therefore be fully studied, it is evident that their curving has been relatively strong, and that therefore the species found probably is *G. occidentale* HALL. It is decidedly stronger than in the closely related *G. anceps* HALL (like *G. occidentale* a Black River form, known from New York, Ontario, Wisconsin, Minnesota, Kentucky, Tennessee). The third known species of the genus, *Gonioceras chaziense* RUEDEMANN[1] of the Chazy (found near Chazy, N.Y.) has somewhat more crowded septa than the arctic specimens and less curved lateral saddles, more like those in *G. anceps*.

Gonioceras occidentale HALL is according to BASSLERS „Bibliographic Index of American Ordovician and Silurian Fossils" known from the lower part of Black River (Platteville) in Wisconsin and Illinois. Further it is found at several localities in Arctic America, collected during the Norwegian expeditions in the „Fram" and the „Gjöa"[2].

The genus *Gonioceras* is furthermore represented in East Asia where a *Gonioceras* sp. has been found, together with

---

[1] Bull. New York. State Mus. 90, 1906, p. 494, pl. 36, figs. 3—4.

[2] HOLTEDAHL: The Cambro-Ordov. Beds of Bache Peninsula. Rep. Sec. Norw. Arct. Exp. in the „Fram" 1898—1902, 1913, p. 10. — HOLTEDAHL: On some Ordovician Fossils from Boothia Felix and King William Land. Videnskaps-Selskapets Skrifter, Kristiania 1912, p. 9, pl. III, fig. 1.

Actinoceras aff. *tenuifilum* HALL (by Rev. Sam. COULING) in North China (in West Shantung) as mentioned by CRICK[1].

TH. KJERULF in 1865[2] cites *Gonioceras* an. *anceps* HALL from the Ordovicium of the vicinity of Kristiania and in the German edition (by GURLT) of his Summary of the geology of southern and middle Norway[3], we find *Gonioceras anceps* again listed from the Ordovician. In his Catalogue of the Fossil Cephalopoda in the British Museum FOORD has (p. 324) among the references to *Gonioceras anceps* HALL also mentioned Prof. KJERULFS, and thus the genus *Gonioceras* has come into the literature as having been found in Norway.

As we are here dealing with a genus of more than common interest, as it seems to have a very restricted distribution, both vertically and horizontally, the question was of some importance and I have therefore looked through the material of Ordovician cephalopods from the vicinity of Kristiania, resting in the paleontological museum of the University at Kristiania, and succeeded in finding some pieces of a straight cephalopod — from the Trinucleus shale of Nakholmen, the locality given by KJERULF in his „Veiviser" — and labelled by KJERULF *Gonioceras* near *anceps* HALL. The pieces belong to a single specimen, a rather rapidly tapering form with length not less than 25 cm., the greatest diameter at the lower end about 9 mm. at the upper 65 mm., a form of quite other proportions than the relatively broad and short *Gonioceras*. The section is lenticular or strongly elliptical, without any doubt due to pressure; the matrix is soft shale. The preservation of the interior is very bad, so by making sections only an indication of a fairly small siphuncle could be seen, yet there is little doubt that we have here a rather conical *Orthoceras* sp. What has, besides the lenticular section, given KJERULF the idea of the form having some relation to *Gonioceras anceps* HALL, must be the existence of a surface ornamentation consisting of undulating transverse striae, that curve in much the same fashion

---

1 Geol. Magazine, Vol. X, 1903, p. 481.

2 Veiviser ved geol. Excursioner i Christiania omegn, p. 9.

3 Die Geologie des südlichen und mittleren Norwegen, 1880, p. 68.

as the lines that in HALLS figure in Pal. New York, I, to which KJERULF refers, mark the septa.

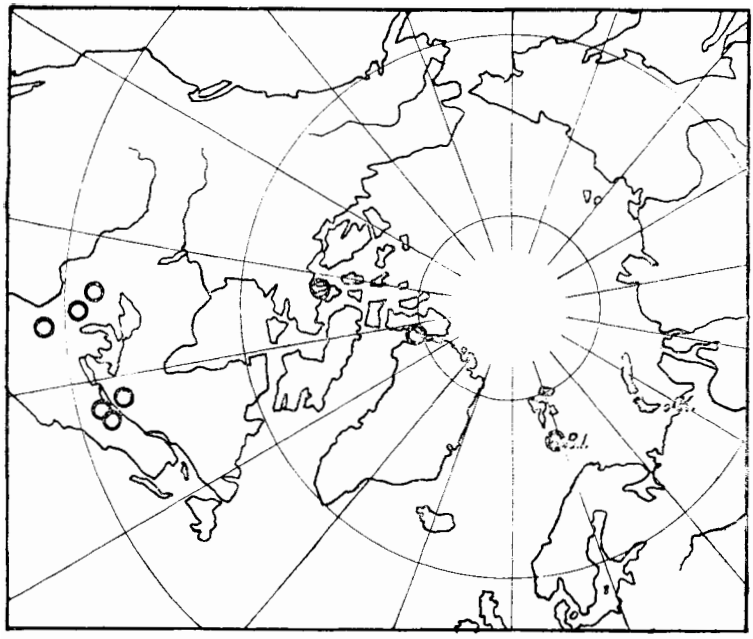
Even if the fossils found are few and mostly so poorly preserved as to allow no certain specific determination, the fauna by containing so characteristic forms as *Gonioceras* (*occidentale*?) sp., and *Actinoceras Bigsbyi* is quite decisive as to the stratigraphical position of this *Tetradium* limestone of the isolated Arctic island. The horizon is of Black River age, probably belonging to the lower part of the division, where the *Gonioceras* forms are most common. The occurrence of a *Tetradium* that comes near to the *T. syringoporoides* of the Stones River also points in that direction.

Of far greater interest than this fixing the age of the zone is the fact shown by the fossils that we are dealing with here — in a district that geographically belongs to the European arctic region — with a fauna of purely American character, showing practically no likeness whatever to the Ordovician faunas of Middle Ordovician time in North-western Europe.

Both *Tetradium* and *Actinoceras* are typical American genera (as far as the Middle Ordovician is concerned), but the greatest interest centers in the occurrence of a *Gonioceras* in these European waters. The very marked American occurrence of this genus has been emphasized by RUEDEMANN[1] who also mentions CRICKS note on the *Gonioceras* from China and says (p. 517): „This exceedingly interesting observation extends the habitat of the genus *Gonioceras* across the entire Pacific-American basin and furnishes further evidence of its having been characteristic of this very ancient oceanic basin". The limits of distribution of the genus has now been expanded very markedly also in another direction, to the north of the American continent, first into high latitudes of Arctic America and now into the European-Arctic district. Instead of speaking of a Pacific-American element (see RUEDEMANN p. 524) we had better speak of a Pacific-American-Arctic element.

[1] Cephalopoda of the Beekmantown etc. New York, State Mus. Bull. 90, 1906, p. 493 and 517.

Except for the fossils mentioned the scanty older and middle Ordovician faunas as yet known from China do not in fact seem to prove the dominance of American fossils there. The fauna described by FRECH in Neues Jahrbuch f. Min. 1895, II, p. 48 from a locality 80 km. east of Nanking consisting of *Asaphus* sp., *Endoceras duplex* WAHL., *Raphistoma sinense* n. sp.,



Map showing situation of Bear Island, *B. I.* Khabarova at *K.* Rings mark occurrences of *Gonioceras.*

Orthisina cf. *squamata* PAHLEN, *Orthis* cf. *calligramma* DALM. on the contrary has a Europaen character. These fossils occurred, however, a good distance to the south of the locality of *Gonioceras*, so we have the possibility that the American element prevails in the north. From another more northern locality, Hoschan in Shantung, close to the one mentioned by CRICK, LORENZ[1] has mentioned a fauna of more uncertain character consisting of *Asaphus Boehmi* n. sp., *Maclurea Logani* SALT., *Hyolithes* sp.;

[1] Zeit. d. d. geol. Gesellsch. 1906, p. 95.

Maclurea (Maclurites) Logani is a Black River form, known from Canada and Arctic America, common also in the Girvan area of Scotland.

The few Ordovician fossils of northern Sibiria[1] does not give any impression of an American faunal district, and when we come to Arctic Russia we meet distinct European faunal elements of the Scandinavian-Baltic type. At Khabarova, on the south side of Yugor Strait, NANSEN collected a number of fossils, which have been described by J. KIÆR[2]. The following forms were found: *Monotrypa* sp., *Orthis* cf. *parva* PAND., and var. *polaris* n. var., *Platystrophia biforata* SCHLOTH., *Strophomena (Rafinesquina) Nanseni* n. sp., *Leptæna (Plectambonites) sericea* SOW., *Torellella* sp., *Megalaspis* sp., *Asaphus* sp., *Asaphus* sp. (juv.)?, *Remopleurides* sp. As KIÆR strongly emphasizes, this fauna is of a marked Scandinavian-Esthonian type, the age corresponding with that of the zone C1 a of the Baltic province, of stage 4 a α of Norway. As to a possible American influence KIÆR states concerning the fauna that: „It is no more closely connected with the North American Silurian than is the Scandinavian-Esthonian itself" (p. 16).

As to the correlation of the zone of the Bear Island fauna, the lower part of Black River of the American system, with the stratigraphical columns of the Scandinavian-Baltic region RAYMOND who, in the author's opinion, has made correlation studies with best results[3] thinks the Lowville (Lower Black River) synchronous with the uppermost part of C1 and with the basal part of 4 b of the Kristiania region. The Khabarova fauna has to be considered only sligthly older than that of the *Tetradium* limestone of Bear Island.

As is well known also the rest of the (upper) lower and middle Ordovician faunas (except the graptolites and bryozoans) of the Scandinavian-Baltic region do not show any nearer relation to

---

[1] A list of the publications concerning the older faunas of Sibiria is given by LORENZ in the paper mentioned.

[2] The lower Silurian at Khabarova. Norwegian North Polar Expedition 1893—96. Scientific Results, IV.

[3] Bull. Mus. Comp. Zoology Harvard College, 56, No. 3. Geol. Series, Vol. X. Shaler Memorial Series, No. 2, I, 1916, pl. 8.

the American faunistic development. With this fact taken into consideration it is of very great interest that no farther away than in the Bear Island a fauna occurs of which we can say that it is no more closely connected with the Scandinavian-Esthonian than is the American equivalent faunas themselves. In the writer's opinion this fact gets its most probable explanation by assuming a land barrier between two different districts of sedimentation of middle Ordovician time, the one characterised by an American-Arctic, the other by a Scandinavian-Baltic faunal element. The many facts pointing towards the existence — at a corresponding time — of a land mass to the north-west of the northernmost, stratigraphically more fully known districts of Southern Norway and Sweden, the Mjösen district in Norway and Jemtland of Sweden, support this supposition. In Scotland a land is generally assumed to have been present in middle Ordovician time in the far north-west, while further to the south-east the marine Llandeilian strata were deposited. Here we find the interesting Girvan deposits in which certain American faunal elements can be traced.

Kristiania, april 1918.

Explanation of Plates.

1

2

3

4

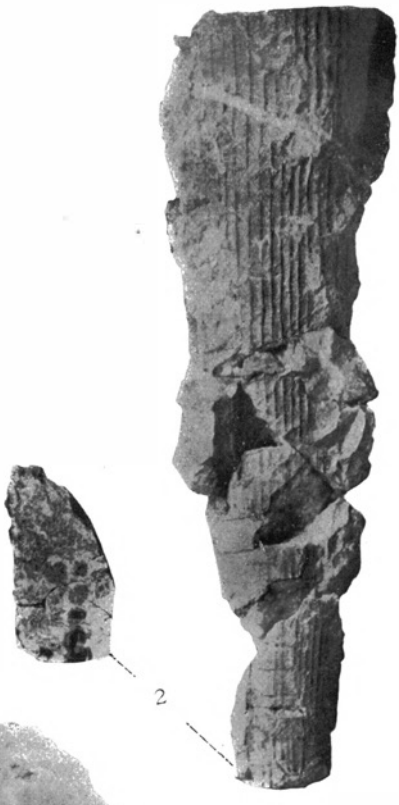
5

1

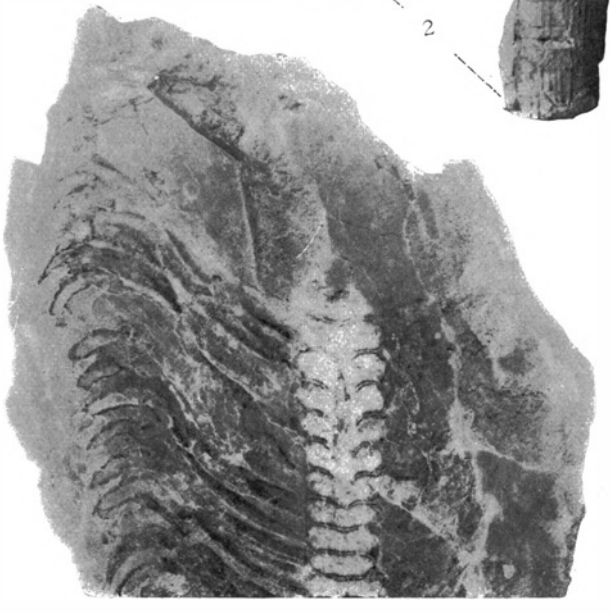
2

3

1



2



3