DET KONGELIGE INDUSTRI-, HÅNDVERK-
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NORSK POLARINSTITUTT

SKRIFTER

Nr. 106

CAMBRIAN AND ORDOVICIAN FOSSILS FROM SØRKAPP LAND, SPITSBERGEN

BY

HARALD MAJOR AND THORE S. WINSNES

WITH 5 PLATES AND 9 TEXT-FIGURES

I KOMMISJON HOS
BRØGGERS BOKTRYKKERIS FORLAG
OSLO 1955

NORSK POLARINSTITUTT
(Formerly Norges Svalbard- og Ishavs-undersøkelser.)
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Skrifter 1—50, see numbers of Skrifter previous to No. 100.

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A. W. BRØGGERS BOKTRYKKERI A/S

Contents.

Preface.

The Norsk Polarinstitutt expedition to Spitsbergen in 1952 had, among other tasks, the geological mapping of Sørkapp Land. This is situated at the southernmost part of Vestspitsbergen and includes the area south of the fjord Hornsund.

Maps constructed after aerial photographs have been available the last few years and are of considerable advantage to the geological work. Parts of the area have been geologically mapped before, by W. Werenskiold and Adolf Hoel in 1919, A. K. Orvin in 1936, and A. Heintz and S. Foyn in 1949.

The mapping party of 1952 included the authors, with four assistants. The party was first landed at Gåshamna at the south side of Hornsund, and from the main camp here Major with two assistants mapped to the east and south and Winsnes with two assistants mapped to the west and south. Later on the main camp was moved south to Stormbukta, from where the surrounding mountains and the mountains in the central part of Sørkapp Land were surveyed. The ice conditions caused some delay from the outset, and another summer will be spent in this area.

Acknowledgment: The authors are indebted to Professor L. Størmer, Paleontologisk Museum, Oslo, for his interest and many helpful suggestions.

Thanks are also due to the four assistants, stud. techn. Chr. Pyk, stud. geol. J. Kjøllesdal, stud. real. O. Josang, and stud. real. I. Bryhni who always did their utmost in camp work and on the excursions.

The authors also wish to thank Mr. and Mrs. R. H. Ragle and Mr. J. Green for their help with the manuscript. The drawings are made by Mr. B. Evensen, Norsk Polarinstitutt, and Miss B. Mauritz, Geologisk Museum, Oslo, has assisted with the photographs.

Oslo, November 1954.

Thore S. Winsnes. *Harald Major.*

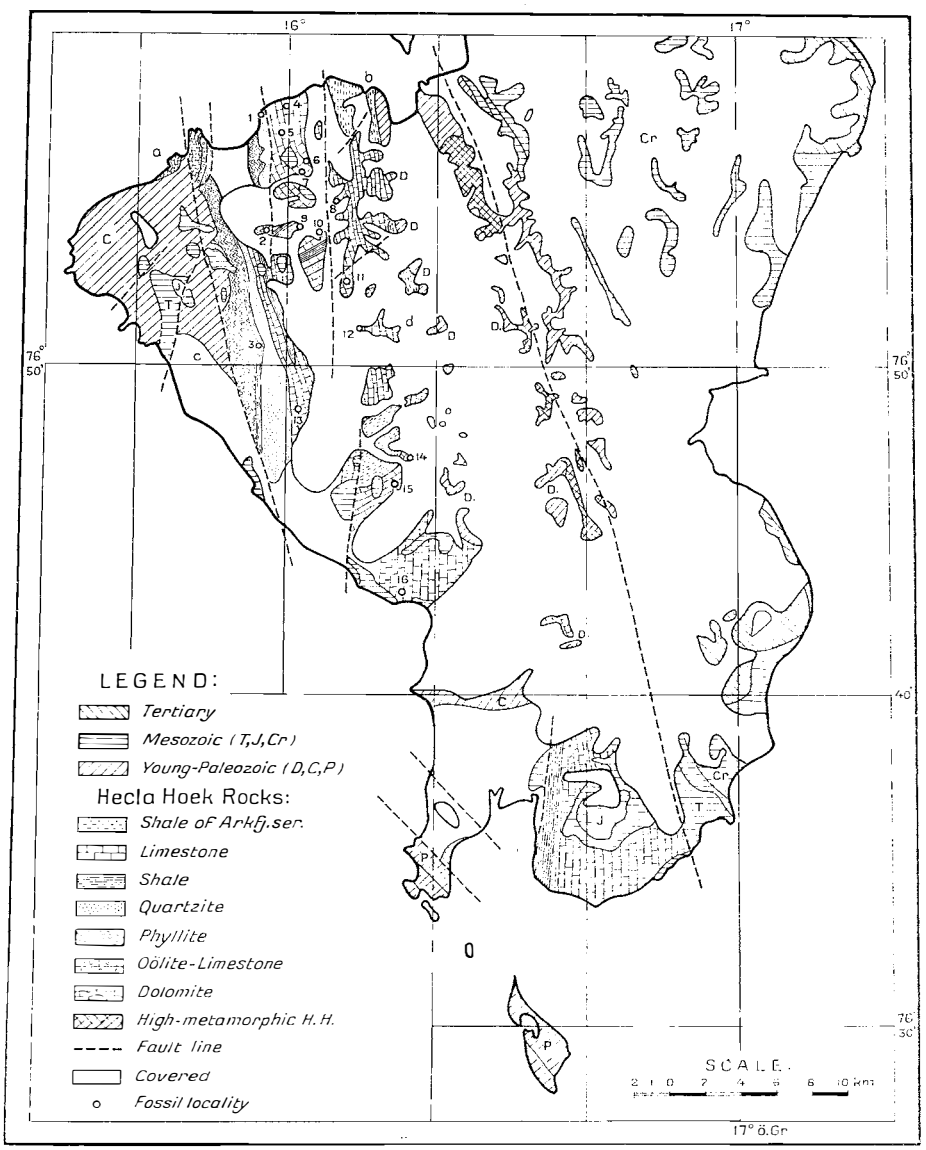

Fig. 1. Geological map of Sørkapp Land.

Fossil localities: 1. East side of Gåshamna. 2. Western part of Midifjellet. 3. Western slope of Wiederfjellet, south of Gråkallen. 4. Rasstupet, north of Tsjebysjovfjellet. 5. Top of Tsjebysjovfjellet. 9. Eastern slope of Tsjebysjovfjellet, at Kørberbreen. 7. Southern slope of Tsjebysjovfjellet, towards Nordfallbreen and Nordfallet. 8. Bastionen, west of Hornsundtind. 9. Eastern part of Midifjellet. 10. Northern tip of Flakfjellet. 11. Southern part of Hestskanka. 12. Western part of Sjdanovfjellet. 13. Southern part of Wiederfjellet. 14. Eastern part of Sokolovfjellet, south of Arkfjellet. 15. Eastern part of Plogen. 16. Southern part of Hilmarfjellet, north of Stormbukta.

Part I.

A Preliminary Description of the Hecla Hoek Rocks and its Cambrian and Ordovician Faunas.

BY THORE S. WINSNES

Introduction.

Hecla Hoek rocks occur in an area in the southern part of Bjørnøya (Bear Island) and in Spitsbergen. Here they are found at Nordaustlandet, at the northeastern part and western coast of Vestspitsbergen and at Prins Karls Forland. The name Hecla Hoek was first introduced by NORDENSKIÖLD in 1863, as the name designating a part of the older metamorphic rocks. (Hecla hooks formation, NORDENSKIÖLD, 1863, p. 17). The name is derived from the mountain Heclahuken in northern Spitsbergen.

Later the term Hecla Hoek became the name of all the metamorphic rocks older than the Downtonian. DE GEER found the first traces of life in the Hecla Hoek rocks of Spitsbergen during the Swedish-Russian Arc-of-Meridian Measuring Expedition, 1899—1902. These consisted of worm tracks which were seen in a dolomite on Krossøya in Hinlopenstretet (KULLING, 1934, p. 192, fig. 17). Fossils from Bjørnøya collected 1898—99 by NATHORST and LINDSTRØM were restudied by HOLTEDAHL who also collected more fossils and worked out the stratigraphy of the Hecla Hoek rocks of Bjørnøya (HOLTEDAHL) 1920 B. The sequence is, from above:

a) Tetradium-limestone of Black River age,
b) Younger dolomite series of Canadian age,
c) Shale-quartzite series, and
d) Older dolomite series (Eo-Cambrian).

The thickness of the sequence is at least 1 000 m and the fossil fauna of an American-Arctic type (HOLTEDAHL, 1920 A, p. 90).

The Hecla Hoek rocks in the northeastern parts of Spitsbergen have been described by KULLING (1934). In a sequence of 4 000 m the lower 3 000 m were called the Murchison Bay Formation and were compared with the Eo-Cambrian Eleonore Bay Formation in East Greenland. The series are succeeded by Eo-Cambrian tillites, and above that the Cape Sparre Formation with some fossils in the upper layers, *Obolus* sp. and *Lingulella* sp. Their age is regarded as probably Lower Cambrian.

No other determinable fossils have been found in the Hecla Hoek rocks of Spitsbergen during the many years of surveying. In 1936 ORVIN collected an indeterminable fossil south of Hornsund, in the thick limestones there. The shape indicates a worm cast, a crinoid stem or a cephalopod siphuncle.

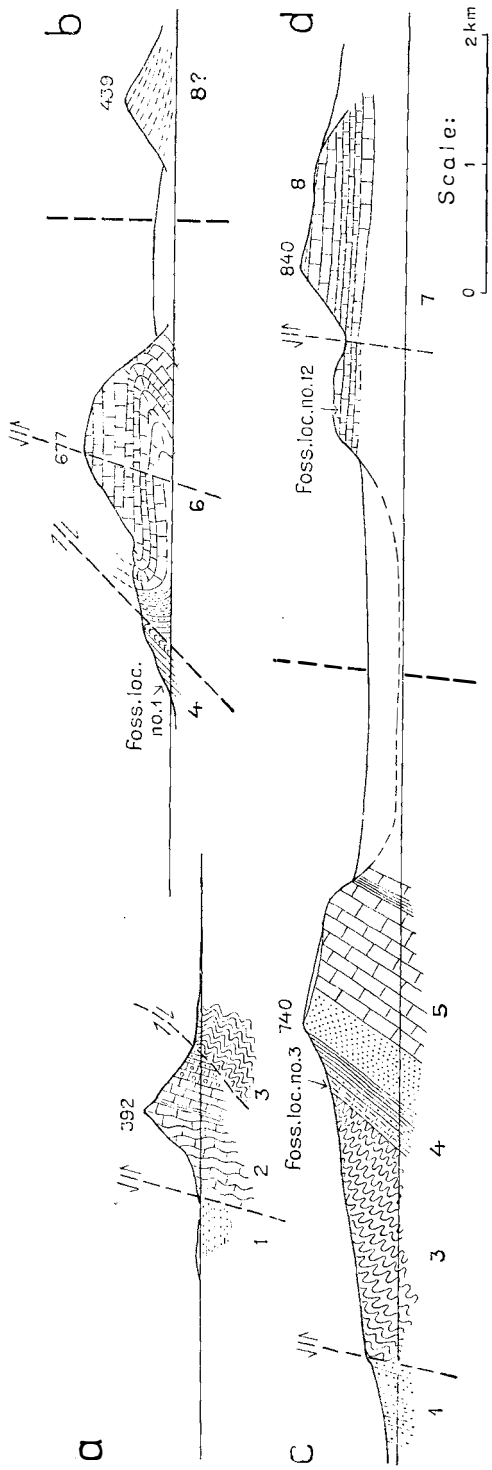

Fig. 2.

In Vestspitsbergen the degree of metamorphism of the Hecla Hoek rocks decreases southwards. The Sørkapp Land, therefore, offers the best possibilities of finding determinable fossils. During the geological mapping of this area in 1952, fossils were discovered in many localities (see map). Because of the interest attached to fossils in the Hecla Hoek rocks, a preliminary description of the new finds is given in the present publication. More material will evidently be collected in the area, and a complete description of the fossils is therefore postponed.

The Hecla Hoek Rocks.

The Hecla Hoek rocks of Sørkapp Land occur in two separate areas. The one in the central part is metamorphosed to such a degree that fossil finds are most unlikely. In the western part, however, there are thick layers of slightly metamorphosed shales and limestones. The sequence is indicated in sections demonstrated in certain localities described below (starting from the west). (See text fig. 2).

Høferpynten series. On the southern side of Hornsund the most western part of the Hecla Hoek rocks occurs. From west to east it consists of: 1) a dolomite zone

Fig. 2. E—W cross-sections just south of Hornsund (a—b) and farther south through fossil localities. Nos. 3 and 12. (c—d). 1. Culmsandstones, 2. Høferpynten ser., 3. Gåshamna phyllite, 4. Slakli ser., 5. Gråkallen ser., 6. Tsjebysjovfjellet limestones (=5?), 7. Sjdanovfjellet ser., 8. Arkfjellet ser.

containing chert, 2) a limestone zone with oölites, and 3) a quartzite zone. These zones form a unit which may be called the Høferpynten series after the name of the locality. The series has a thickness of 350—400 m and dips steeply (60—70°) to the west. A fault line separates this series from Lower Carboniferous sandstones which continue westward. The Høferpynten series has been thrust over a formation of phyllites lying to the east.

The Gåshamna phyllite, mostly exposed farther south, is green and contains lenses of white quartzite. The dip, in general, is 45° to the west, and the thickness appears to be 1 500 m. A repetition of the sequence may, however, occur.

Slakli series. East of the phyllite follows a series, well developed west of Wiederfjellet (foss.loc. no. 3 on the map., fig. 1), consisting of 1) a sandy limestone with a thin intraformational conglomerate, 2) a light, solid quartzite-bed, and 3) a black slate. Since the limestone was found in scree only, the thickness is not known, but the series is nearly 100 m in thickness. In the sandy limestone fossils of Lower Cambrian age, mostly trilobites, were collected.

Gråkallen series. Further east the Slakli series is followed by 1) a bed of quartzite, which increases southward where it attains a thickness of about 300 m, and 2) a light limestone containing thick beds of slates in the northern part. The slates pinch out to the south where the limestone increases to about 400 m. In the limestone, near the quartzite bed, fossils of Lower Ordovician age were found (foss.loc. no. 13), a fact which indicates that the whole sequence is inverted (see text fig. 2).

East of Gåshamna, at Tsjebysjovfjellet, the structures are more complicated. It has been possible, however, to work out certain sections, the stratigraphy of which is demonstrated. This area was mapped by Major, and the following description of Tsjebysjovfjellet is kindly supplied by him.

At the east side of Gåshamna the inverted green Gåshamna phyllite crops out on the somewhat gentler sloping west side of Tsjebysjovfjellet. A dark coloured phyllitic limestone, of which only 5 meters are exposed, was found at the shoreline to the northwest of that mountain. It contains some few Lower Cambrian fossils. It is stratigraphically overlain by a sequence of light, yellowish brown, dolomitic sandstone and dolomite and limestone beds (Hornstullodden formation), that take part in an acutely infolded drag-fold alongside the western slope of Tsjebysjovfjellet (fig. 2). The thickness is estimated to be 80 m. The north side of the mountain forms a most beautiful escarpment (Rasstupet) in which a good section through the limestone beds, dipping but slightly to the southwest, is demonstrated. To the west the beds are bent up in an oblique syncline; to the east there is a smaller distinct, narrow anticline, recumbent to the east. The rock sequence begins, at the base, with an about 120 m thick, dark coloured, silicified and fossiliferous limestone (Nigerbreen limestone), its upper part containing a characteristic *Ceratopea* bed (foss.loc. no. 4). This is followed by an 80 m thick, lighter

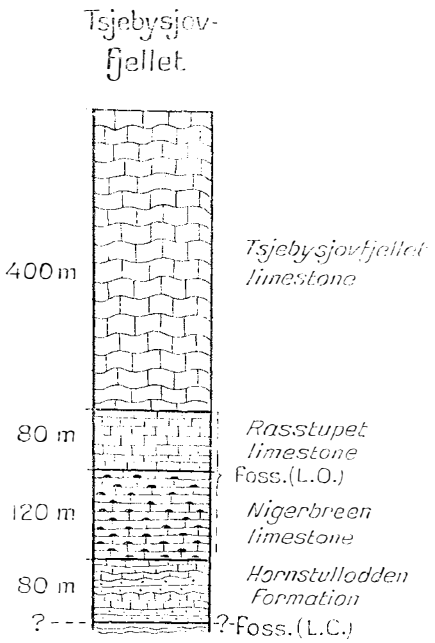

Fig. 3. Stratigraphical column of the rocks of Tsjebysjovfjellet.

coloured limestone (Rasstupet limestone), still containing some few fossils (mostly badly preserved gastropods). Upwards the sequence is continued by an at least 400 m thick series of compact, partly dolomitised limestone beds, forming the upper part of the escarpment as well as the major part of the mountain surface of Tsjebysjovfjellet; at the southern slope the underlying beds crop out towards Nordfallbreen. In these underlying beds several fossils were found (locality no. 7).

Compact, thick-bedded dolomites and limestones of the Tsjebysjovfjellet series are also found in the peaks to the south of Tsjebysjovfjellet (Nordfallet). They dip to the southwest and contain some thin, sandy layers as well as some beds of dolomite and limestone breccia.

The gently sloping surfaces of Tsjebysjovfjellet and Nordfallet form an escavated pre-Triassic peneplain, partly covered by thin-bedded yellowish Triassic sandstone layers. The continuation of this peneplain to the west, across Kørberbreen, is interrupted by an uplifted area with prominent peaks, among them the Hornsundtind, which consist of dark coloured limestones, the age of which is still unknown.

Sjdanovfjellet series. To the south of Tsjebysjovfjellet follow more limestones (fig. 2). In the more or less horizontal beds of Sjdanovfjellet the following sequence is demonstrated (from below): 1) More than 300 m of light limestone containing a few dark silicified beds, 2) 2—300 m dark, silicified limestone with few light beds, and 3) 100—150 m light fossiliferous limestone and dolomite with marly limestone at the top. As shown below the fossils indicate Canadian age.

At Stormbukta, about 10 km farther south, another sequence of limestone occur which may be approximately the same age. The characteristic beds of the Sjdanovfjellet series have, however, not been recognised. In the limestone which seems to have a thickness of about 400 m, fossil gastropods (*Maclurea* sp.) have been found.

Arkfjellet series. Above Sjdanovfjellet series are more than 200 m of slates with thin layers of dolomite. They are best exposed in Arkfjellet and the name Arkfjellet series is therefore suggested. The lower $^2/_3$ of the series consist of a dark, partly arenaceous slate with thin layers of dolomite. The upper $^1/_3$ forms a dark brown and black slate separated from the lower part by a limestone conglomerate. The only fossils found in this series consist of a few not determined fossil fragments, observed in a thin section of an arenaceous limestone just above the conglomerate.

In this area the Devonian sandstones rest with a marked unconformity on the Hecla Hoek rocks.

In the west, however, the Hecla Hoek rocks are overlain by Lower Carboniferous and Triassic rocks, the latter being deposited on a peneplain, well demonstrated in the mountains of western Sørkapp Land.

The fossils found belong to two distinctly different faunas. One consists mainly of Lower Cambrian trilobites, the other of Lower Ordovician gastropods (cephalopods in part II).

The Cambrian fossils.

The Cambrian fossils were found in three localities, nos. 1, 2, 3, (fig. 1) in a loose piece of rock on the glacier near the locality no. 2. The calcareous fossils have been cleaned by means of tiny chisels and needles. Some fossils with phosphate tests were cleaned by phosphorus and acetic acid.

PTEROPODA (Incerti ordinis)

Genus *Hyolithellus* BILLINGS, 1872

Hyolithellus cf. *micans* BILLINGS, 1872

Material. Many specimens of this fossil were found both in calcareous slate and in crystalline limestone. Most of the tests are uncomplete, probably destroyed by wave or current action before sedimentation. The phosphatic tests are black and easily recognisable.

Description. The cylindrical shells taper very slightly, and the circular cross-section has a maximum diameter of 3.4 mm. The largest specimen found measures 36 mm in length. The surface is smooth, except for very faint transverse lines, possibly representing growth lines or due to the preservation.

Remarks. The present form corresponds closely to the description of *H. micans*. This species occurs in several localities in the Lower Cambrian of Scotland, U.S.A. and Canada. STORMER (1925) describes a very similar

form from the Lower Cambrian of Ustaoset, Norway. The fossil also bears a resemblance to *H. robustus* COBBOLD, 1920, which, however, seems to be a larger form. (COBBOLD, 1920, p. 362, pl. 24, fig. 23).

Occurrence. The species occurs at Midifjellet (loc. no. 2, fig. 1), together with *Hyolithes* sp., *Serrodiscus* spp., *Calodiscus* sp. and *Olenellus* spp.

Genus *Hyolithes* EICHWALD, 1840

Hyolithes sp.

Pl. I, figs. 1, 2

Material. Two nearly complete moulds and a few black phosphatic fragmentary shells were found in calcareous slate and crystalline limestone.

Description. The length of the more complete specimens is 25 and 30 mm, the width at the aperture 9 and 10 mm. The cross-section is subtriangular, weakly convex on the dorsal side, and highly convex on the ventral side, the height being 5 and 6 mm. The longitudinal section is slightly curved, with a convex dorsal side. No lips are visible at the aperture. One of the moulds shows weak, slightly curved growthlines on the ventral surface. Some faint longitudinal striæ which are 1 mm apart at the aperture are also indicated.

Remarks. The surface ornamentation resembles that of *H. americanus* BILL., illustrated by WALCOTT (1890, pl. 75, fig. 2g), though the shape of this form deviates from the Spitsbergen one. The shape corresponds to that of *H. (H.) mutatus* POULSEN, 1932 (1932, p. 23, pl. 3, figs. 12—17) from the Lower Cambrian Bastion Formation of East Greenland. Until better material is obtained, the identity with this form remains uncertain.

Occurrence. The specimen was found at Midifjellet (foss. loc. no. 2, fig. 1). The same layers contain *Serrodiscus* spp., etc.

GASTROPODA

Genus *Platyceras* CONRAD, 1840

Platyceras primaevum BILLINGS, 1872

Pl. I, fig. 4

1886 *Platyceras primaevum*, WALCOTT — Bull. U.S. Geol. Surv. Vol. 30, p. 130, pl. 12, figs. 5, 5a.

1888 —»— , SHALER — Bull. Mus. Comp. Zool. Harvard Coll. Vol. 16, no. 2, p. 30, pl. 1, 2, figs. 10a—c.

1890 —»— , WALCOTT — U.S. Geol. Surv. 10th Ann. Rep. P. 618, pl. 74, figs. 11, 11a.

Material. Several well preserved specimens of this form were collected. The moulds which in several cases have been freed from the surrounding matrix, contain phosphate.

Description. The diameter of the spiral (coil) is 1—2 mm. It consists of 1—1½ advolute volutions. The spire is nearly flat or even depressed,

and the umbilicus is wide. The cross-section of the whorl is flat on one side. The increase of the whorl thickness seems to differ from one specimen to another, and the form, therefore, is rather polymorphous. Because of the preservation no surface structures are observed.

Remarks. In U.S.A. *Pl. primaevum* occurs in several Middle and Upper Cambrian localities. BROOKES KNIGHT and others doubt whether this form is a gastropod. That it may be a pteropod has been suggested by ULRICH (BROOKES KNIGHT, 1952, p. 40).

Occurrence. In Spitsbergen it is found at Midfjellet (foss.loc. no. 2, fig. 1). In the same layers are found *Serrodiscus* spp., etc.

BRACHIOPODA

Genus *Obolella* BILLINGS, 1861

Obolella cf. *atlantica* WALCOTT, 1889

Pl. I, fig. 5

Material. Two dorsal valves were found in a sandy shale. The surface structure is preserved on one of them.

Description. The valve is nearly circular with a diameter of 6 mm. It is gently convex with the highest part near the obtuse beak. The surface structure shows fine lines spreading fan-like from the beak, the lateral curving outwards, but the medial ones are straight.

Remarks. The shape, the size, and the structures are very similar to those of *Obolella atlantica* (WALCOTT, 1890, p. 611, pl. 71, figs. 1—1e) from the Lower Cambrian of New Foundland. The present specimens resemble also, to some degree, *Obolella cromatica* BILLINGS, 1861 (WALCOTT, 1886, p. 112, pl. 11, fig. 1). Without better material no definite determination is possible.

Occurrence. The specimens were collected at Midfjellet (foss.loc. no. 2, fig. 1). In the same layers were found *Serrodiscus* spp., etc.

TRILOBITA

Genus *Serrodiscus* RICHTER and RICHTER, 1941

Serrodiscus bellimarginatus (SHALER and FOERSTE, 1888)

Pl. I, figs. 6, 7, 8, 9

1888 *Microdiscus belli-marginatus* sp.n., SHALER — Bull. Mus. Comp. Zool. Harvard Coll. Vol. 16, no. 2, p. 35, pl. 2, figs. 19 a, b.

1890 —»— *bellimarginatus,* WALCOTT — U.S. Geol. Surv. 10th Ann. Rep. P. 630, pl. 81, figs. 2, 2b.

1899 —»— —»— mut. *insularis,* MATHEW — Trans. Roy. Soc. Canada. 2. ser., vol. 5, sect. 4, p. 75, pl. 3, figs. 6 a, b.

1931 *Eodiscus bellimarginatus,* COBBOLD — Quart. Journ. Geol. Soc. London. Vol. 87, p. 460, pl. 38, figs. 12, 13, 14.

1941 *Eodiscus (Serrodiscus) bellimarginatus,* RICHTER and RICHTER — Abh. senckenb. naturf. Ges. Abh. 455, p. 23.
1944 —»— *bellimarginatus,* KOBAYASHI — Journ. Fac. Sc. Imp. Univ. Tokyo. Sec. 2, vol. 7, part 1, p. 52, pl. 1, figs. 5a, b.
1952 *Serrodiscus bellimarginatus,* RASETTI — Journ. Paleont. Vol. 26, no. 3, p. 445, pl. 42, figs. 12—17.

Material. Several cephala and pygida were found in a crystalline limestone. The preservation is rather good, but it was difficult to free the fossils from the matrix (because the tests consist of calcite also.)

Description. Cephalon: Width 0.4—0.55 mm; length 0.5—0.7 mm. The prominent rim is of equal width around the sides of the cephalon, in the front, however, it is a little wider. On each side 8—9 tubercles are seen. The posterior part of the rim turns strongly upward into a pointed «tongue» at the general corners. The strongly convex and smooth cheeks and glabella are separated by a deep furrow.

Pygidum: The lengths and the widths are the same as those of the cephalon. They are strongly convex, and the axis consists of 10 segments. The pleural lobes are smooth. On one specimen a short spine or tubercle is seen on the first 3—4 segments (Pl. I, fig. 6). The narrow rim is of constant width, but curves upwards against the thorax. In one sample spines are seen projecting downwards from the rim.

Remarks. The original illustration and description by SHALER is not sufficient for a determination of this specimen, but later works accompanied by good illustrations (RASETTI, 1952, pl. 52, figs. 12—13) confirm that our form is *Serrodiscus bellimarginatus.* RICHTER (1941, p. 23) states that this species has no spines on the rim of the pygidum.

Occurrence. The specimens were found at Midifjellet (foss.loc. no. 2, fig. 1). The same layers contain *Olenellus* spp., etc.

Serrodiscus cf. *speciosus* (FORD, 1873)

Pl. I, figs. 10, 11, 12, 13

1873 *Microdiscus speciosus* sp. n., FORD — Amer. Journ. Sc. P. 137.
1888 —»— —»— , SHALER — Bull. Mus. Comp. Zool. Harvard Coll. Vol. 16, no. 2, pl. 2, fig. 26.
1890 —»— —»— , WALCOTT — U.S. Geol. Surv. 10th Ann. Rep. P. 632, pl. 81, figs. 5—5c.
1907 —»— —»— , LAKE — Palæontograph. Soc. London. P. 33, pl. 3, fig. 7.
1941 *Eodiscus (serrodiscus)* cf. *speciosus,* RICHTER and RICHTER — Abh. senckenb. naturf. Ges. Abh. 455, p. 27, pl. 1, figs. 17, 21, pl. 4, fig. 61.
1944 *Paradiscus speciosus,* KOBAYASHI — Journ. Fac. Sc. Imp. Univ. Tokyo. Sec. 2, vol. 7, part 1, p. 50, pl. 1, fig. 4.
1952 *Serrodiscus speciosus,* RASETTI — Journ. Paleont. Vol. 26, no. 3, p. 444, pl. 52, figs. 1-11.

Material. Several cephala and pygida were collected in a crystalline limestone. The tests consist of calcite, and were difficult to free from the matrix. The ones best preserved, however, are good enough to warrant a description.

Description. Cephalon: The cephalon is 6.5—10 mm wide, 3.0—3.5 mm high, and the length is about the same as the width. The rim is narrow on the sides and broader at the front. No distinct tubercles have been observed on the cephala; but on the rim of a small specimen, presumably a juvenile animal, some very fine tubercles can be seen on the right side (pl. I, fig. 11). As in *Serr. bellimarginatus* the rim turns upwards and expands into a tongue on each side in the neck section. The glabella and cheeks are strongly convex, smooth, and separated by a deep furrow.

Pygidum: The pygidum has the same outline as the cephalon. The rim is narrow, and in one sample vertical pointed spines can be observed. The side lobes are smooth, and the rather broad axis has 10 or perhaps as many as 12 segments. The pygidum is strongly convex.

Remarks. The measurements are like those stated as maximums by FORD (1873, p. 137). The tubercles on the rim of a specimen described and shown by LAKE (1907, pl. 3, fig. 7) are lacking. Our material is very like *Serr. speciosus* described by RASETTI (1953, pl. 52, figs. 1, 3). In his fig. 3 are shown the spines on the rim of the pygidum. Even though no prominent tubercles are seen on the cephalon rim, which may be due to the preservation, the author has the view that the form must be *Serr. speciosus* or very nearly related to it.

Occurrence. The material was found at Midifjellet (foss.loc. no. 2, fig. 1) in a rock fragment on the glacier near by, and at Wiederfjellet in the Slakli series (foss.loc. no. 3, fig. 1). In the same layers were found *Olenellus* spp. etc. *Serr. speciosus* is an index fossil of the upper part of the Lower Cambrian of U.S.A.

Genus *Calodiscus* HOWELL, 1935

Calodiscus agnostoides (KOBAYASHI, 1943)

Pl. II, fig. 1

1847 *Agnostus lobatus* sp. n., HALL — Nat. History N.Y. Part 6, vol. 1, p. 258, pl. 67, fig. 5.
1886 *Microdiscus lobatus*, WALCOTT — Bull. U.S. Geol. Surv. Vol. 30, p. 156, pl. 15, fig. 1.
1888 —»— —»—, SHALER — Bull. Mus. Comp. Zool. Harvard Coll. Vol. 16, no. 2, p. 36, pl. 2, fig. 13.
1890 —»— —»—, WALCOTT — U.S. Geol. Surv. 10th Ann. Rep. p. 632, pl. 81, fig. 4.
1943 *Brevidiscus (?) agnostoides* sp. n., KOBAYASHI — Proc. Imp. Acad. Tokyo. Vol. 19, part 1, no. 9, p. 39.
1944 *Brevidiscus agnostoides*, KOBAYASHI — Journ. Fac. Sc. Imp. Univ. Tokyo. Sec. 2, vol. 7, part 1, p. 58, pl. 1, fig. 3.
1952 *Calodiscus* —»—, RASETTI — Journ. Paleont. Vol. 29, no. 3, p. 442, pl. 51, figs. 12—16.

Material. It was possible to free three cephala of this small trilobite from a crystalline limestone.

Description. The widths of the cephala are 1.3, 1.4, and 1.7 mm, and the lengths are 0.9, 1.0, and 1.2 mm. The ratio of W/L is 1.4. The rim is of

equal width, but for two small up-turned «tongues» at the postero-lateral corner. The cheeks are strongly convex and separated from the glabella by a well defined, deep furrow. The glabella has the typical shape with three glabellar furrows and an expanded anterior end.

Remarks. The cephala show a striking resemblance to a *Calodiscus agnostoides* illustrated by RASETTI (1952, pl. 51, fig. 15).

Occurrence. The material was found in a rock fragment on the glacier near Midifjellet (foss.loc. no. 2, fig. 1). In the same rock were found *Serrodiscus* spp., etc.

Cal. agnostoides is before found in the Lower Cambrian in eastern parts of N. America.

Calodiscus cf. *agnostoides* (KOBAYASHI, 1943)

Pl. II, figs. 2, 3

Material. From a crystalline limestone it has been possible to free three cephala and three pygida.

Description. The widths of the cephala are 2.3, 2.4, and 2.5 mm, and the lengths are 1.5, 1.5, and 1.8 mm. The ratio of W/L is 1.4—1.5. The cheeks and glabella are strongly convex, and the latter have three glabellar furrows and an expanded anterior end. The last furrow (the occipital furrow) is deep and the occipital ring is expanded. The prominent border is curved, and of constant width.

The pygida are 1.7, 1.7, and 2.0 mm wide and 1.3, 1.3, and 1.6 mm long. The ratio of W/L is 1.3—1.35, and the height is as much as 0.8 mm. The axis of the pygida has five well defined segments. The side lobes have the same number of segments, on which are seen pleural furrows. The border is crossed by these furrows which help to give the outer edge its serrate appearance.

Remarks. These forms are very much like the *Cal. agnostoides,* and the larger measurements may indicate that we here are dealing with quite adult specimens. The three pygida are similar to that of *Cal. lobatus* (HALL) shown by RASETTI (1952, pl. 51, fig. 10). The measurements lie between those of the previously described *Cal. agnostoides* and *Cal.* cf. *agnostoides* cephala. They are grouped under the latter because no *Cal. lobatus* cephalon has been found in the collected material.

Occurrence. The samples were found in a rock fragment on the glacier near Midifjellet (foss.loc. no. 2, fig. 1), together with *Serrodiscus* spp., etc.

Calodiscus sp. inc.

Pl. I, fig. 14—15

Material. Four cephala were cleaned from the matrix. They were found in a crystalline limestone and are fairly well preserved.

Description. The cephala have a round outline, somewhat longer than wide. Their widths are from 1.2—1.3 mm, and their lengths 1.3—1.4

mm. The ratio of W/L is 0.93. The prominent border is curved, and broader in front than on the sides. At the general corners the border turns very sharply and goes inwards and a little forwards against the occipital ring. The cheeks are very convex and separated from the glabella by a deep furrow. The glabella is long and a little narrower in the middle. The surface is smooth, with a fairly deep occipital furrow. Thorax and pygidum are unknown.

Remarks. It has not been possible to find this form described. The head shield bears some resemblance to that of *Cal. parkeri* (WALCOTT), (1886, p. 157, pl. 16, figs. 2, 2a). The latter, however, is bigger and the border very narrow. *Cal. sculptus* (HICKS) (1871, p. 400, pl. 16, figs. 9, 10) may also be considered, but according to the illustrations this form is bigger, the glabella shorter, and the border more narrow. A further determination must await more material.

Occurrence. These cephala were found in a rock fragment on the glacier near Midifjellet (foss.loc. no. 2, fig. 1).

Genus *Pagetia* WALCOTT, 1916

Pagetia sp.

Pl. II, fig. 4

Material. A single cephalon was found in limestone, but the preservation is not very good.

Description. The cephalon is 2.4 mm wide and 2.1 mm long. The front is semicircular in shape, the sides straight, forming a right angle with the transverse posterior margin. The border is wide in front, forming a brim. The cheeks are small, with the strongest elevation near the posterior margin. The glabella is low in front, sloping up backwards, where it forms a strong spine, more than 1 mm in length. No glabellar furrows can be seen.

Remarks. The shape in general is like *Pagetia connexa* WALCOTT (1887, p. 194, pl. 1, fig. 4), also described by RASETTI (1948, pl. 1, figs. 22—25), but the preservation is so poor that no finer details can be seen. The glabella also bears a resemblance to *Eodiscus spininger*. SAITO states the possibility that this is a *Pagetia* because it may have facial sutures. For a better determination more material must be collected.

Occurrence. The specimen was found in the Slakli series at Wiederfjellet, together with *Olenellus* spp. and a *Serrodiscus* sp. (foss.loc. no. 3, fig. 1).

Genus *Olenellus* HALL, 1862

Material. Many fragments of the genus *Olenellus* have been found at Midifjellet and Wiederfjellet. A small specimen was also found on the eastern side of Gåshamna, Hornsund. The fragments represent several species, at last three, and are of several sizes. In two cases it has been possible to clean the whole cephalon, and in a third an attempt has been made to combine different pieces probably belonging to the cephala of one species.

Olenellus cf. *thompsoni* HALL, 1859

Pl. II, fig. 10

Material. The material consists of a cephalon fairly well preserved. It has been a little compressed from ahead, but not greatly deformed. The left genal spine was lost during the freeing process.

Description. The width of the strongly convex cephalon is 22 mm, the median length is 9 mm and the genal spines at least 5 mm. The front of the glabella is destroyed, but appears to have been strongly convex. Its greatest width is at the anterior end of the eyes where it is about 6 mm. In front it is semicircular, ending 1 mm from the marginal furrow. Posteriorly it tapers down to 5 mm in width. Three pairs of glabellar furrows can be seen extending somewhat backwards and towards the middle. The occipital furrow is deeper on the sides than in the middle part, and the occipital ring has a short node and a pair of furrows. The distinct border is 1 mm wide, but the posterior part is narrower. The genal corner forms an arc, and the spine here is a continuation of the lateral border. The eye lobes are crescentiform and 4 mm long. The pleurons found are all of *Olenellus* type.

Remarks. With only this single cephalon it is difficult to determine the species, but it bears a close resemblance to *Olenellus thompsoni* HALL, 1859 (WALCOTT, 1886, p. 17, figs. 1, 2, 9).

Occurrence. The fossil was found in limestone of the Slakli series on the west side of Wiederfjellet (foss.loc. no. 3, fig. 1).

Olenellus sp. I

Pl. II, fig. 5

Material. A mould of a cephalon was found in a shaly limestone. It is very small and represents, perhaps, a juvenile stage.

Description. The parabolic cephalon has a width of 10 mm and a length of 8 mm. The anterior part of the glabella forms a broad wedge and nearly reaches the border in front. Farther back three glabellar furrows can be seen passing nearly straight across the glabella. The eyes are large, forming a curved ridge 4 mm long, reaching nearly as far as to the occipital furrow. The border has a width of about 1 mm, the posterior part curving backwards and inwards to the occipital ring. The general spine is directed backwards and outwards at an angle of 15° and is at least 3 mm long. No finer ornamentation can be seen.

Remarks. This cephalon has some likeness to *Olenellus truemani* WALCOTT, 1913 (1913, pl. 54, figs. 8, 9). Without more material and more work it cannot be determined with certainty. It also bears a slight resemblance to *O. gilberti* MEEK, 1824, as illustrated by WALCOTT (1910, pl. 36, figs. 1, 2).

Occurrence. The fossil was found on the east side of Gåshamna, Hornsund (foss.loc. no. 1, fig. 1).

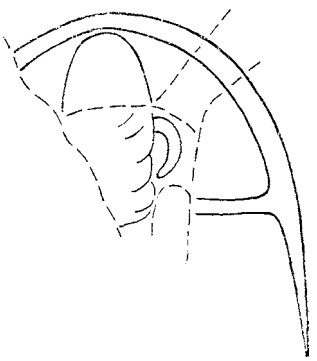

Fig. 4. *Olenellus* sp. II. Cephalon reconstructed by fitting together drawings of separate pieces. Nat. size.

Olenellus sp. II

Pl. II, figs. 6, 7

Material. Several pieces of cephala and pleurons are preserved in limestone. The pieces are mostly very broken but in some cases larger parts of cephala have been found.

Description. By fitting together drawings of the larger pieces probably belonging to this form it was possible to get a fair impression of the cephalon (text fig. 4). It must have been at least 45 mm broad and 40 mm long. The genal spine alone is found to be 20 mm long in some cases. The glabella is strongly convex and apparently narrow at the anterior end, but less so further back. One specimen indicates a broader anterior portion of the glabella, but this specimen may perhaps belong to another species. Four pairs of glabellar furrows can be seen directed backwards and towards the middle. They are shallow and indistinct in front, but deeper further back. The border is 2.5 mm wide and the surface has fine, longitudinal ridges. The pleurons are all of *Olenellus* type. A piece of a «telesonic» spine has also been found.

Remarks. Because of the fragmentary material the author does not feel competent to make any suggestions as to species.

Occurrence. The pieces were all found at Midifjellet, nearby, and at Wiederfjellet (foss.loc. nos. 2, 3, fig. 1). The same layers also contain *Serrodiscus* spp., etc.

Gen. et spec. indet. I

Pl. II, fig. 8

Material. The left half of a cephalon is preserved in a crystalline limestone. Most of the glabella is absent.

Description. The whole cephalon may have been about 20 mm wide and 12 mm long. The border is prominent and continues directly into a thick genal spine. The entire surface of the cheek has a meshwork which at the border develops into more parallel ridges. The eye lobes are 5 mm

long and curve but slightly. On the glabella three furrows can be seen directed a little backwards towards the middle.

Remarks. The form resembles, to some degree, the *Wanneria ellae* POULSEN (1932, p. 41, pl. 13, figs. 2, 7, and 8) from the Lower Cambrian of East Greenland.

Occurrence. The fossil was found in the Slakli series on the western side of Wiederfjellet (foss.loc. no. 3, fig. 1), together with *Olenellus* spp. and a *Serrodiscus* sp.

Gen. et spec. indet. II

Pl. II, fig. 9

Material. A single piece of the frontal part of a glabella was found in a crystalline limestone.

Description. The glabella is 6 mm wide and the length exposed is the same. On the glabella appear three pairs of furrows directed backwards towards the middle and nearly meeting at an angle of 120°. The surface has an unusually strong ornamentation of small ridges, passing unevenly across the glabella.

Remarks. This fragment may belong to or be closely related to the form illustrated in Pl. II, fig. 8, and described above; on the other hand it also resembles *Protapotekephalos arctostriatus* RAYMOND (1937, p. 1085, pl. 1, fig. 4), from the Upper Cambrian, Vermont, U.S.A. Without more and better material no determination is possible.

Occurrence. The sample was found in the Slakli series on the western slope of Wiederfjellet (foss.loc. no. 3, fig. 1). The same rock contains *Olenellus* spp., etc.

The Ordovician fossils.

GASTROPODA

Genus *Ceratopea* ULRICH, 1911

Ceratopea sp.

Pl. III, figs. 1, 2, 6

Material. Several specimens of this very interesting fossil have been found in limestone. The fossils are more or less silicified, and in several cases it has been possible to free them from the matrix by means of hydrochloric acid, acetic acid, or phosphoric acid. The rock is often compressed, but in certain cases but slightly deformed fossils have been obtained.

Description. The general shape of the fossil is a slightly curved cone, but also nearly straight ones and strongly curved ones have been obtained. Its maximum length is 50 mm and width 23 mm. More commonly they are

30—40 mm long and 15—20 mm wide. A longitudinal ridge, the carina, which turns anticlockwise during the growth, gives the cross section a tropoform outline. A muscle cavity is situated at the broader end; its deepest part near the anti-carina side. The depth is ¼ of the total length of the fossil. The surface of the fossil shows clearly defined growth lines.

Remarks. *Ceratopea* was first described from the Durness limestone and interpreted as an operculum to *Maclurea peachi* by SALTER (1859, p. 378, pl. 13, figs. 1b, 3, 4, 5). ULRICH realised that this could not possibly be the operculum of any known *Maclurea* and gave it the name *Ceratopea*. (ULRICH, 1911, p. 665). The Spitsbergen form and that of SALTER seem to be conformable. The known American species described by BASSLER (1909, pl. 20, fig. 3) and ODER (1932, p. 133) seem on the other hand in general to be different. Only *Ceratopea subconica* ODER, 1932, bears resemblance to some of the Spitsbergen specimens.

The Spitsbergen form shows some characteristics which seem to contradict the assumption of *Ceratopea* being an operculum. The fossil seems to have been hollow, a feature indicated by an inner filling of large crystals of calcite, dolomite and quartz. The cavity has a thinner wall than the rest. This is shown by the silification which always is less here than in the rest of the fossil. Because of the less satisfactory preservation the connection between the muscle cavity wall and the outer wall is not demonstrated. In a few cases the muscle cavity wall is missing. This may possibly suggest that the muscle cavity wall was not connected with the rest of the shell and thus could be considered as an operculum. This could mean that *Ceratopea* was a *Tryblididae* gastropod of simple design. If the supposed inner cavity primarily had been filled with calcite, thus forming one solid shell, its weight would have been 8 grams or more. This is a very heavy operculum for a gastropod with an apertural diameter of 20 mm. The weight of such a gastropod would hardly have exceeded 15 grams. In one locality several hundred specimens of *Ceratopea* were the only fossils found in a bed of about 2 meters in thickness. A sorting due to wave action seems in this case hardly probable.

In a material from the Younger dolomite series of Bjørnøya, collected and described by HOLTEDAHL, a fossil very like *Ceratopea,* but smaller than the Spitsbergen form, is mentioned (HOLTEDAHL, 1920B, p. 129, pl. 12, fig. 2). The material also contains fragments of a specimen more like the Spitsbergen form.

Occurrence. The fossils were found in large quantities in the Nigerbreen limestone, at the northern and southeastern parts of Tsjebysjovfjellet and at the southern part of it. (foss.loc. nos. 4, 6, 7, fig. 1) A few specimens were also found at Flakfjellet (foss. loc. no. 10, fig. 1).

Genus *Hormotoma* SALTER, 1859

Hormotoma sp.

Pl. III, fig. 3

Material. The available material consists of two large and several small pieces of internal moulds found in limestone.

Description. One of the large pieces is 21 mm long and shows 8 volutions. At the broadest end it is 6 mm wide, and the last whorl is 3 mm. No surface ornamentation can be seen. A definite determination to species is hardly possible.

Remarks. The present specimens resemble to some extent *Hormotoma gracilis* var. *gracilissima* SALTER, 1859, from the Durness limestone (SALTER, 1859, p. 379, pl. 13, figs. 7, 8), *Hormotoma gracilis* HALL (SHIMER and SHROCK, 1944, p. 45), and *Hormotoma artemisia* BILL. (BASSLER, 1909, pl. 20, figs. 1, 2) from Beekmantown and *Murchisonia linearis* BILL., (1863, p. 127, figs. 31 (81)) from lower Chazy.

Occurrence. This gastropod was found in the Sjdanovfjellet series at Hestskanka and Sjdanovfjellet (foss.loc. nos. 11, 12, fig. 1).

Genus *Maclurea* (LESUEUR, 1818)

Maclurea spp.

Pl. III, figs. 8, 9

Material. Several badly preserved fragments of larger gastropods were found in limestone. The fossils are mostly preserved in sandy limestone, and are always deformed.

Description. The diameter of the shell varies from 20 to 50 mm, and the number of volutions from 1 to 3. One side is rather planular, and the other has a deep and narrow umbilicus. In one section an umbilicus angle of 90° was noted.

Remarks. Without better material no determination is possible. The material may comprise more than one species.

Occurrence. The material was found in several localities in Sørkapp Land in the thick series of limestones (foss. loc. nos. 7, 8, 11, 12, 13, 14, 15, and 16, fig. 1).

Genus *Straparollina* BILLINGS, 1865

Straparollina aff. *holtedahli* STRAND, 1932

Pl. III, figs. 4, 5

Material. A silicified small gastropod occurring in limestone was separated from the matrix by means of acid. A part of the last whorl and the aperture is lacking, which is also true of the nucleus and the first whorl. The rest is in a fairly good state of preservation.

Description. The gastropod is 13 mm wide near the fourth whorl. The height of the three preserved whorls is 7 mm, and the total height must have been nearly 8 mm. The apical angle is about 100°. The whorls are rounded and have a prominent suture. On the last whorl a faint carina can be seen 1 mm from the suture, and traces of another are visible near the periphery. No growth line can be seen, and the existence of a sinus can therefore not be decided. The umbilicus is narrow, 3 mm wide at the opening, and extends to the apex. Along the border of the umbilicus remains of a carina are visible on the last whorl.

Remarks. The shape of this gastropod is very similar to that of *Straparollina holtedahli* STRAND, 1932, which, however, seems to be smoother, with a more prominent carina at the umbilicus (STRAND, 1932, p. 358, figs. 1a, b). The obscure angularity and faint concave band of *Str. pelagica* BILLINGS, 1865, resemble that of the Spitsbergen species (BILLINGS, 1865, p. 223, fig. 205). The general shape of the Spitsbergen species also shows a similarity to *Str. asperostriatus* BILLINGS (1863, p. 153, fig. 84). A closer determination to species is hardly possible with the present material.

Occurrence. The gastropod was found in the upper part of the Sjdanovfjellet series at Sjdanovfjellet (foss.loc. no. 12, fig. 1).

BRACHIOPODA

Genus *Diaphelasma* ULRICH and COOPER, 1936

Diaphelasma cf. *breviseptatum* ULRICH and COOPER, 1936

Pl. III, fig. 7

Material. A silicified ventral valve was found in limestone. It was possible by careful use of acid and lac to separate the specimen from the matrix. The hinge and area are not preserved.

Description. The outline is transversally elliptical measuring 21 mm in width and 13 mm in length. The valve is convex, reaching a height of 4 mm. The surface shows fine radiating striæ, but no growth lines. No sulcus is visible, but a gentle ridge on the posterior $\frac{1}{3}$ of the valve indicates an obtuse beak. The interior shows a spondylum 2.5 mm long and 4 mm wide. From this extends a median septum halfway to the edge. About 1 mm from the teeth an alar-septum extends out to the side and then forward keeping a distance of 1 mm from the median septum. On one side it is about 1 mm long, but on the other a continuation makes a total length of 4 mm.

Remarks. The elliptical shape of this brachipod is very like that of *D. breviseptatum* ULRICH and COOPER, 1936, which is somewhat smaller, measuring 11 mm in length and 17 mm in width (1936, p. 629). The ratio

W/L is 0.65 which is the same as the ratio of the Spitsbergen form. In a later illustration of *D. breviseptatum* the biggest specimen is about 20 mm wide (ULRICH and COOPER, 1938, pl. 48c, fig. 25). Since the Spitsbergen form lacks a sulcus, it is hardly identical with the species mentioned. There is also a possibility that the valve belongs to the genus *Syntrophina*. This possibility cannot be proved without observing the dorsal plates, but no dorsal valve has been found.

Occurrence. The valve was found in the Rasstupet limestone on the southern part of Tsjebysjovfjellet (foss.loc. no. 7, fig. 1).

PORIFERA

Genus *Receptaculites* BLAINVILLE, 1830 (Incertae sedis)

Receptatulites sp.

Pl. III, fig. 10

Material. The fossil fragment forms a light coloured network of calcite on the surface of a dark limestone.

Description. The fragment measures 6 cm by 2 cm, the sides of the slightly curved rhombic meshes are 2 mm long and 0.5—1.0 mm in thickness.

Remarks. This genus is mentioned in «Index Fossils of North America» by SHIMER and SHROCK as belonging to strata ranging from the Black River to the Devonian. BILLINGS describes two species from the Mingan Islands north of the St. Lawrence Gulf as belonging to the Calciferous Formation (=Beekmantown) (BILL., 1865, p. 359). A determination to species of the present form is hardly possible.

Occurrence. The specimen was found in the Rasstupet limestone at the southern part of Tsjebysjovfjellet (foss.loc. no. 7, fig. 1).

Table 1.

Lower Cambrian fossils.

	Spitsbergen	Appalachian province	Scotland	Shropshire	Other places
Hyolithellus micans	×	×	×	×	E. Greenland W. Norway
Hyolithes sp.	×	cf.	cf.	cf.	several (cf.)
Platyceras primaevum	×	×			
Obolella atlantica	cf.	×		cf.	
Serrodiscus bellimarginatus	×	×		×	S. Spain
Serrodiscus speciosus	cf.	×		×	—»— (cf.)
Calodiscus agnostoides	×	×			
Olenellus thompsoni	cf.	×	aff.		

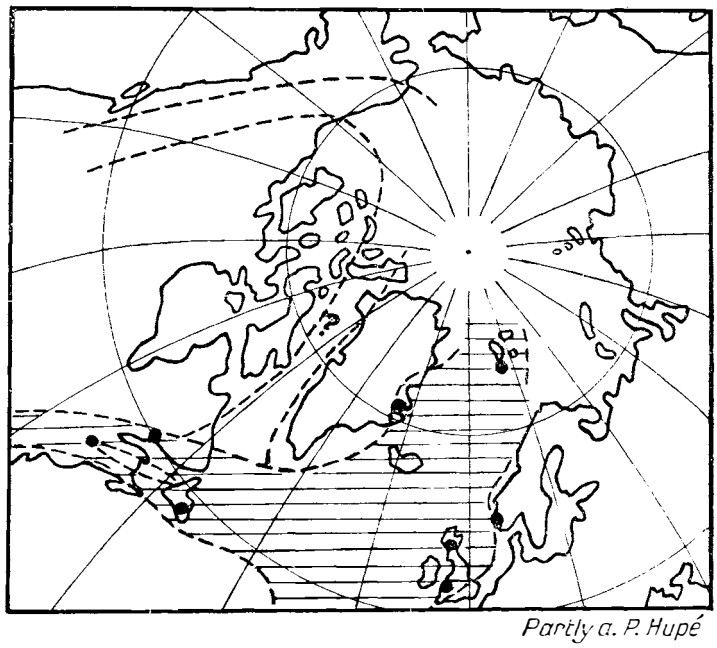

Fig. 5. The Lower Cambrian «*Olenellus-Callavia* Sea».

Age of the Faunas.

The Cambrian fauna is, as shown in table 1, of a North American type. The fossils occur in the northeastern part of the North American continent, in the Olenellus zone, the Protolenus zone (New Foundland), the Schodack form (New York), and the Hoppin slate (Massachusetts). In Shropshire, Great Britain, similar fossils are found in the layers A_{c3-5} of the Lower Cambrian. There is, therefore, no doubt that some of the Hecla Hoek rocks are of upper Lower Cambrian age (Georgian Epoch). The distribution of the faunas suggests that a common geosyncline extended from the Appalachians across Great Britain and Scotland, along the western coast of Norway (*Hyolithellus* at Ustaoset), and as far northeast as Spitsbergen. POULSEN (1932, p. 65) also found a fauna on East Greenland, partly similar to the one found in the Appalachian Province, but the fauna of Greenland has no species in common with Spitsbergen, with a possible exception of a Hyolithes. In 1953, however, the author was informed by letter that the English geologist COWIE a. o. have found Eodiscs in East Greenland. The geosyncline, therefore, also seems to have touched the eastern coast of Greenland. To the south there was a connection between this «*Olenellus-Calavia* Sea» and the northwestern part of the «*Redlichia* Sea». This is shown by the mixed fauna in the western Mediterranean area (HUPÉ, 1952, p. 46) (see map, text fig. 5).

The Ordovician fauna is also of American-Arctic type (as can be noted in table 2). It can be compared with the fauna of the Beekmantown Group,

Table 2.

Lower Ordovician fossils.

	Spitsbergen	Appalachian province	Scotland	Other places
Ceratopea sp.	×	aff.	cf.	E. & N. Greenland Bjørnøya ?
Straparollina holtedahli	aff.	aff.		W. Norway
Hormotoma sp.	×	cf.	cf.	Several. (cf.)
Maclurea sp.	×	cf.	cf.	—»—
Diaphelasma breviseptatum . .	aff.	×		
Protocycloceras lamarcki	cf., aff.	×	aff.	E. Greenland (cf.) Bjornøya (cf.)
Protocycloceras arkansasense	cf.	×		
Oneotoceras loculosum	cf.	×		
Beekmannoceras priscum	×	×		
Polygrammoceras sp.	?	×		Norway, Sweden
Bathmoceras? arkansasense . .	aff.	×		
Cassinoceras sp.	×	×	aff.	Bjornøya.
			×	W. Norway (aff.)
Vaginoceras longissimum	cf.	×		

The cephalopods are described in part II.

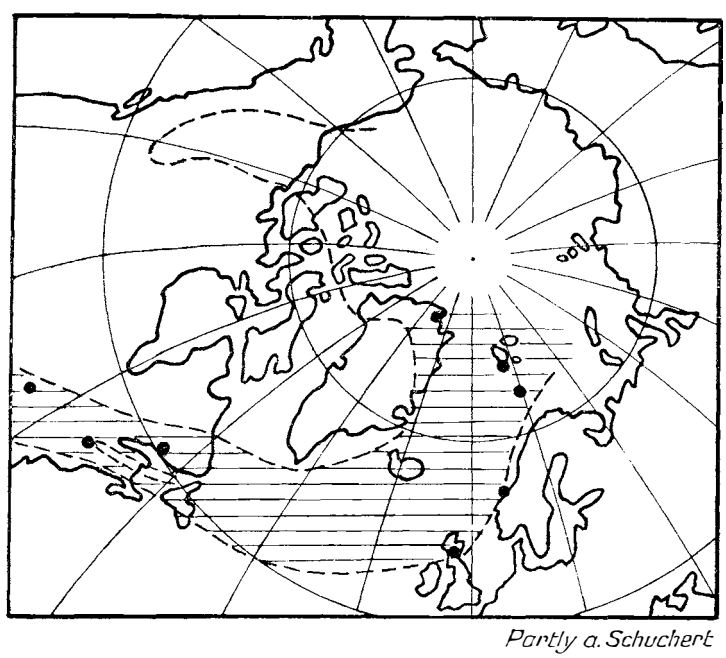

Fig. 6. The Lower Ordovician (Canadian) American-Arctic Sea.

Canadian Series, on the North American continent, and in Scotland with the fauna of the Balnakeil group in the Durness limestone. Any fossils considered to be of Black River age, as those from the Tetradium limestone of Bjørnøya, have not been found. It is, however, possible that such fossils exist; but at least most of the big limestone series in the Hecla Hoek is of Lower Ordovician age. This proves that the geosyncline which extended from the northeastern coast of the North American continent, to Northern Scotland, the west coast of Norway (Smøla), and to Bjørnøya, also extended farther on to Spitsbergen (see map, text fig. 6). The fauna shows little resemblance to that of Greenland. POULSEN, though, has recently pointed out that several species exist which are common both to East Greenland and the Durness limestone, Scotland (POULSEN, 1951). TROELSEN has described a fauna from Northeast Greenland containing two forms (a *Ceratopea* and a *Protocycloceras* sp.) resembling those of Sørkapp Land (TROELSEN, 1949, p. 18).

As a result of the field work and the fossils found, a stratigraphic section through the Hecla Hoek rocks of Sørkapp Land can be attempted and is briefly described below (see text fig. 7).

The Høferpynten series with its content of oölites coincides with the Older dolomite series of Bjørnøya and the Murchison Bay Formation of Nordaustlandet. These are of Eo-Cambrian age and are correlated with the Porsanger-dolomite of Norway and the Eleonore Bay Formation of East Greenland. In the break between the Høferpynten series and the adjacent thick Gåshamna phyllite is, north of Hornsund, found a thick conglomerate or tillite. An Eo-Cambrian tillite is also reported from Nordaustlandet in the Sveanor Formation (KULLING, 1934, pp. 182—88). At Bjørnøya a break exists between the Older dolomite series and the following Shale-quartzite series. The Gåshamna phyllite at Sørkapp Land coincides with the latter. It is considerably thicker in Spitsbergen, but the lower boundary of the series of Bjørnøya is determined by a thrust plane and the shale may therefore primarily have been much thicker here.

It cannot be decided whether the phyllite is of Eo-Cambrian or Cambrian age. A tillite farther north, situated south of Bellsund, may belong between the Gåshamna phyllite and the Slakli series, and indicates an Eo-Cambrian age of the phyllite. More field work may solve this problem. The fossil-bearing Slakli series is of Lower Cambrian age, but the adjacent thick quartzite of the Gråkallen series does not contain any fossils to determine its age. The limestone above sontains fossils of Lower Ordovician age. A break somewhere between the Lower Cambrian and Lower Ordovician must be present. This break is also recognized in Great Britain and in the Appalachian Province.

The fossils found in the thick beds of limestone farther east and south indicate a Lower Ordovician age.

The Arkfjellet series has not yielded any determinable fossils up to now, but it must be considered as representing the youngest — Lower Ordovician

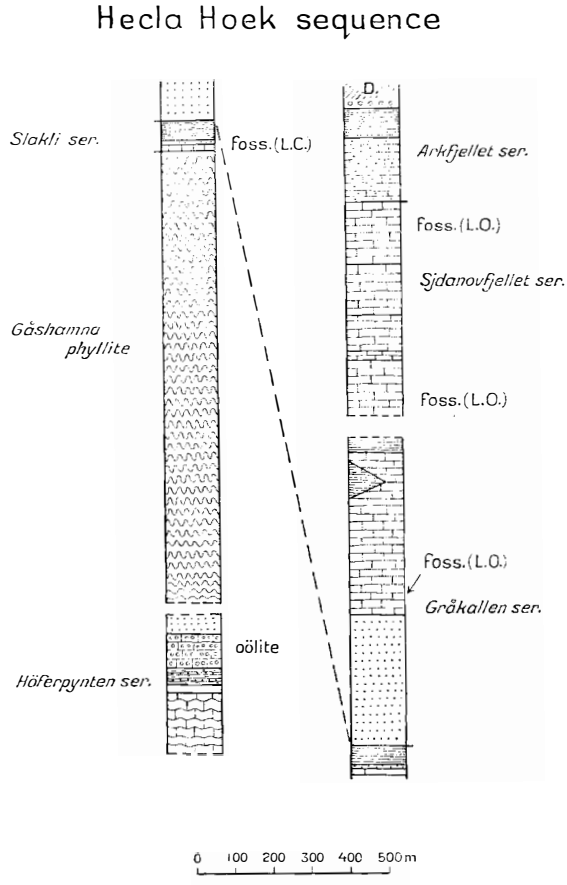

Fig. 7. Stratigraphical column of the Hecla Hoek rocks in the western part of Sørkapp Land.

or younger — part of the Hecla Hoek rocks at Sørkapp Land. It is hoped that the preliminary stratigraphy of this area will provide a «key» to the stratigraphy of the Hecla Hoek rocks of Spitsbergen, but a lot still remains to be done in field and laboratory work. Above all it will be necessary to find more fossils and to follow the known horizons northwards where other large areas of Hecla Hoek rocks are present.

The preliminary results may suggest the following division of the Hecla Hoek rocks exposed in the area:

Arkfjellet series ..	Lower Ordovician or younger (pre-Downtonian).
Sjdanovfjellet series Gråkallen series ..	Lower Ordovician, Beekmantown Group.
Slakli series	Lower Cambrian.
Gåshamna phyllite	L. Cambrian or Eo-Cambrian.
Høferpynten series	Eo-Cambrian.

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Part II.

Ordovician Cephalopods.

BY HARALD MAJOR

Description of the fossils.

Eleven or twelve different cephalopod species belonging to four of the Nautiloidea orders (FLOWER and KUMBEL, 1950), are described. The fossils occur in a recrystallised limestone, their preservation permits a comparison with earlier described forms, but closer determination with regard to genera and species is in many cases difficult to work out.

Order *ELLESMEROCERATIDA* FLOWER, 1950

Family *Protocycloceratidae* KOBAYASHI, 1934

Genus *Protocycloceras* HYATT, 1900

Type species. *Orthoceras lamarcki* BILLINGS, 1859, renamed by HYATT (1900, p. 518).

Protocycloceras cf. *lamarcki* (BILLINGS, 1859)

Pl. V, figs. 1, 2, and 4

1859. *Orthoceras lamarcki*, BILLINGS. Geological and Natural History Survey of Canada. Vol. 4. P. 362.

1900. *Protocycloceras lamarcki*, HYATT. Zittel-Eastman, Textbook of palæontology. Vol. 1. Ed. 1. P. 518.

1906. *Protocycloceras lamarcki*, RUEDEMANN. Bull. N.Y. St. Mus. No. 90. Pp. 441—443. Fig. 15. Pl. 15, figs. 1—6, and pl. 16, figs. 1, 2.

1920 B. *Orthoceras?* sp., HOLTEDAHL. Norsk Geol. Tidsskr. Vol. 5. Pp. 129—130. Pl. 13, fig. 1.

1921. *Protocycloceras* cf. *lamarcki*, FOERSTE. Bull. Denison Univ. Jour. Sci. Labs. No. 19. Pp. 270—271. Pl. 27, fig. 5 and pl. 33, figs. 5 A, B.

1938. *Protocycloceras lamarcki*, FOERSTE. Spec. Papers. Geol. Soc. Amer. No. 11. Pp. 77, 82—83. Pl. 14, fig. 5.

1944. *Protocycloceras lamarcki*, ULRICH, FOERSTE, MILLER, and UNKLESBAY. Spec. Papers, Geol. Soc. Amer. No. 58. Pp. 79, 80, pl. 40, figs. 1—11.

Type specimen. *Orthoceras lamarcki* BILLINGS, 1859, renamed by HYATT (1900) and designated by FOERSTE (1938) (G.S.C. 550 a, b).

Material. One 97 mm long part of a phragmocone has been found. The surrounding dark schistous limestone is on either side of the specimen compressed to half of its original thickness. The adoral part of the conch has collapsed under the pressure, so that only the quartz-filled siphuncle has retained its shape.

Orientation. The siphuncle is here regarded as ventral in position.

Description. A cross-section of the adapical part is elliptically depressed, its height 10 mm and width 13 mm; 30 mm adoral to this section it measures 12 mm and 16 mm. The lateral aperture angle is thus 5°, and the dorso-ventral angle is 4°. The annular distance is 2 mm, as indicated on some acid-etched parts of the conch surface. The probably recrystallised test has been further studied in a sagittal thin section; it forms light, 0.5 mm thick ribbons on either side of the phragmocone, and here the annulæ form peculiar double wave shapes, the significance of which cannot be explained at present. The septal walls, as demonstrated by their trace lines in the sagittal section, as well as in the cross-section, are transverse dorsal to the septum and slope adorally to the ventral side of it. The suture lines form a small, flat dorsal saddle and a somewhat higher ventral one. The septal distance is 3.3 mm. Finegrained calcitic episeptal and hyposeptal deposits can be seen increasing adapically, while the greater part of the camera is filled with secondary light-coloured coarse-grained calcite.

The siphuncle is comparatively large with an elliptical cross-section, the height and width of which are 4.5 mm and 7 mm. The siphuncle is asymmetrically situated, its distance from the lateral wall being 1.5 mm and from the dorsal wall 4 mm. The septal necks seem to be very short, but they cannot, even in thin sections, be well distinguished from the connecting rings. The inner part of the siphuncle is filled with light, coarsely crystalline quartz.

Remarks. The present specimen resembles very much a *Protocycloceras lamarcki* from the uppermost beds of Beekmantown age at the Valcour shore of Plattsburg, New York, figured by RUEDEMANN (1906, fig. 15, pl. 15, figs. 2—5). It seems also to be in fairly good accordance with the holotype, from the Upper ? Canadian in Huntingdon County, Quebec, selected by FOERSTE (1938, pp. 77, 82—83). In the holotype the siphuncle seems to have a less ventral position. This feature seems, however, to be subject to change during the ontogenetic development: «The siphuncle of *Protocycloceras* . . . is markedly ventral of the center, especially in the early stage of the shell», FLOWER (1941, p. 24).

Occurrence. The present specimen was found at the south side of Tsjebysjovfjellet in the lower part of the Rasstupet limestone (foss.loc. no. 7, fig. 1). *Protocycloceras lamarcki* and forms closely related to it are known from the Canadian of Quebec, New Brunswick, Ontario, Greenland and Bjornoya.

Protocycloceras aff. *lamarcki* (BILLINGS, 1859)

Pl. IV, figs. 11, 12

Material. A 60 mm long part of a phragmocone has been found.

Orientation. The flattened side of the siphuncle is here regarded as the ventral one; also the endosiphotube is situated in the dorsal part of the siphuncle.

Description. The length of the straight fragment is 60 mm and the dorso-ventral apical angle is 8°. In a cross-section 17 mm from the adapical end of the specimen it is elliptically depressed, with a height of 9 mm and a width of 15 mm. Round ,transverse annulæ are seen on its dorsal side. Their width is about equal to that of the grooves between them, their height is 0.5 mm and the annular distance is 2.5 mm. The annulæ are crossed by faint, sigmoidal liræ, spaced at about $^3/_4$ mm, the length of their sigmoidal shapes equalling the annular distance. The suture lines cannot be seen. The natural, somewhat oblique, longitudinal section through the adoral part shows, however, the septa curving concavely adorally from the venter to the dorsum. This indicates that the suture lines must form lateral lobes and ventral and dorsal saddles. In a sagittal section through the adapical part the septa are seen to pass almost transversely from the siphuncle towards the venter, while they are moderately concave adorally at the dorsal side. The septal distance is 2 mm. The siphuncle is situated but slightly ventrally, its height is 3.7 mm, its width 4 mm, as measured 17 mm from the adapical end. It is surrounded by a 0.2 mm thick, dark layer (connecting ring?). The interior is filled with grey limestone containing a slightly dorsally placed, thin, dark endosiphotube with a more or less cruciform cross-section. In a sagittal thin section of the adapical part 4 septa are seen as dark, contourless lines. Septal necks and connecting rings cannot, however, be clearly distinguished, owing to recrystallisation. The siphuncle segments of the adapical end appear to be slightly concave externally, whereas they seem to be more convex adorally.

Remarks. The present specimen is similar to *Protocycloceras lamarcki* as described by FOERSTE (1938, pp. 77, 82—83), but it is distinguished from it by its more central siphuncle, its septa sloping adorally from the venter, and by its sigmoidal liræ transversing the annulæ. The Spitsbergen form may belong to a new species, but until more satisfactory material is obtained, this is hardly possible to decide.

Occurrence. A single specimen was found at the south side of Tsjebysjovfjellet in the lower part of the Rasstupet limestone (foss.loc. no. 7, fig. 1).

Protocycloceras cf. *arkansasense* ULRICH, FOERSTE, MILLER, and UNKLESBAY, 1944

Pl. IV, fig. 10

1944. *Protocycloceras arkansasense*, ULRICH, FOERSTE, MILLER, and UNKLESBAY. Spec. Papers, Geol. Soc. Amer. No. 58. P. 81, pl. 43, figs. 1—10.

Material. Part of one phragmocone, shown in a natural ventral section, has been found.

Orientation. The greatest part of the cameral deposits are located in the ventral part of the camera.

Description. The phragmocone is straight and 50 mm long; its width is 7 mm in the adoral part and 5 mm in the adapical part; the lateral aperture angle is only 2°. An adoral cross-section is depressed in the ratio of 1.75:1, while the adapical end is but faintly elliptical. In this part the internal mold of the test, with transverse annulæ, is demonstrated, though badly preserved. In a longitudinal section of the adoral end the test can be seen as a narrow white, faintly waved calcitic line, showing the annulæ well in accordance with the septal sutures. The transverse septa curve adorally near the conch surface. Their concavity does not exceed half a septal distance, which is 2.5 mm. Episeptal and hyposeptal deposits are found along the septa, and mural deposits can also be seen in the adapical part. These deposits occur in the ventral half only. At the two septa next to the adoral one the deposits do not reach in to the siphuncle, and the septa can be seen as very thin, light grey lines in the grey matrix. At their septal joints they curve but slightly adapically, passing into a 0.2 mm thick siphuncular layer. This can be interpreted as an ellipocoanitic structure, similar to what has been described in other species of *Protocycloceras* (FLOWER, 1941, p. 24). The siphuncle is subcentral, its height 1.5 mm, its width 2 mm. The siphuncular segments of the adapical part are cylindrical, while those of the adoral part are faintly convex externally.

Remarks. As far as can be seen the dimensions and forms are in good accordance with *Protocycloceras arkansasense* ULRICH, FOERSTE, MILLER, and UNKLESBAY, 1944, except that the siphuncle of the present specimen is less ventral. The transverse liræ of *P. arkansasense* may possibly occur also in the Spitsbergen form.

Occurrence. The present specimen was found at the south side of Tsjebysjovfjellet in the Rasstupet formation (foss.loc. no. 7, fig. 1). The material on which the species *Protocycloceras arkansasense* was based, occurs in abundance in the Smithville formation (Lower Ordovician) in Arkansas.

Family *Ellesmeroceratidae* KOBAYASHI, 1934

Genus *Oneotoceras* ULRICH, 1926

Type species. *Cyrtoceras loculosum* HALL, 1861, renamed by BUTTS (fide ULRICH), 1926.

Oneotoceras loculosum (HALL, 1861)

Pl. IV, figs. 6—8

Type specimen. (U.S.N.M. 108, 459) designated by ULRICH, FOERSTE, and MILLER, 1943.

1861. *Cyrtoceras loculosum*, HALL. Report of the Superintendent of the Geol. Survey Wisconsin. 1861. P. 42.

1926. *Oneotoceras loculosum*, BUTTS (fide ULRICH). Spec. Rep. Alabama Geol. Surv. Vol. 14. Pl. 15, figs. 8, 9.

1943. *Oneotoceras loculosum*, ULRICH, FOERSTE, and MILLER. Spec. Papers. Geol. Soc. Amer. Vol. 49. Pp. 145—146. Pl. 65, figs. 1—3. Pl. 66, figs. 6—12. Pl. 67, figs. 1—10. Pl. 68, figs. 13, 14.

Material. One phragmocone, shown in cross-section close to the living chamber, was isolated by etching with acetic acid, whereby its adapical end unfortunately was lost.

Orientation. The siphuncular, concavely curved side is regarded as ventral.

Description. The length of the phragmocone, including the lost adapical end, is estimated at 30 mm. It is endogastrically cyrtoceroid, and the radius of curvature of the concave side is 13 mm, while that of the convex side is 30 mm. It is laterally compressed with flattened or even concave lateral zones, located closer to the dorsum than to the ventrum. The height increases only slightly adorally from 24 mm to 25 mm, while the greatest width decreases from 16 mm to 14 mm, the widest part being near the ventral side. On the inner mold of the conch surface narrowly spaced suture lines are indicated as well marked ridges, their distance being 1.7 mm. They are almost transverse, except for a broad and shallow dorsal lobe, not higher than one septal distance. A scar in the ventral surface shows how the septa slope adorally, close to the conch wall. The siphuncle, as seen in adapical section, is elliptically compressed, its height is 9 mm and its width 6 mm; it is of ventral position, but not in contact with the conch wall. The siphuncle which is filled with a dark matrix, widens abruptly where it reaches the living chamber.

Remarks. The present specimen is well in accordance with *Oneotoceras loculosum* of the Oneota dolomite near Madison, Wisconsin, except for the somewhat larger and less ventrally placed siphuncle.

Occurrence. The present specimen was collected at the western foot of Sjdanovfjellet in the upper part of the Sjdanovfjellet series (foss. loc. no. 12, fig. 1). Representatives of the genus *Oneotoceras* have so far only been collected from the Upper Ozarkian of the U.S.A. *Oneotoceras loculosum* has been found in the Oneota dolomite of Wisconsin and Minnesota, the Gasconade dolomite of Missouri, as well as in the Chepultepec dolomite of Tennessee, all of which belong to the Lower Canadian series.

Oneotoceras sp.

Pl. IV, fig. 9

Material. One part of the phragmocone, seen in cross-section, was freed from the enclosing rock material by etching with acetic acid.

Orientation. The concave, siphuncular side is regarded as ventral.

Description. The length of this specimen is 21 mm and its width only 7 mm. The suture lines appear as densely spaced ribs, sloping adorally to the dorsum. They form a clear saddle, a broad, lateral lobe, and a rounded, large, dorsal saddle. In total the suture lines advance about two septal distances from the ventral to the dorsal side, in spite of its retreating almost one septal distance in the ventral saddle. The central parts of the septa seem to be almost transverse as far as can be seen from some lateral grooves formed during the etching. The siphuncle appears only in an uneven adoral cross-section, being 5 mm high and 3 mm wide, and nearly ventrally placed.

Remarks. This specimen seems to belong to the genus *Oneotoceras*. The width is, however, smaller than that of any earlier described *Oneotoceras* sp.

Occurrence. This single specimen was found together with the above mentioned *Oneotoceras* cf. *loculosum* (HALL) in the upper part of the Sjdanovfjellet series, at the western side of Sjdanovfjellet (foss.loc. no. 12, fig. 1).

Family *Beekmanoceratidae* ULRICH, FOERSTE, and MILLER, 1943

Genus *Beekmanoceras* ULRICH and FOERSTE, 1936

Type species. *Cyrtendoceras ? priscum* RUEDEMANN, 1906, renamed by ULRICH and FOERSTE, 1936.

Beekmanoceras priscum (RUEDEMANN, 1906)

Pl. V, fig. 6

1906. *Cyrtendoceras ? priscum*, RUEDEMANN. Bull. N.Y. St. Mus. Vol. 90. Pp. 430—431. Pl. 2, figs. 2—5.

1936. *Beekmanoceras priscum*, ULRICH and FOERSTE. Bull. Denison Univ. Jour. Sci. Lab. Vol. 30. P. 264.

1943. *Beekmanoceras priscum*, ULRICH, FOERSTE, and MILLER. Spec. Papers. Amer. Geol. Soc. No. 49. Pp. 155—157. Pl. 70, figs. 17—21.

Material. One specimen, forming part of the phragmocone, has been found exposed in a natural, almost sagittal section.

Orientation. The concave side of the curved conch is here considered to be the ventral one.

Description. The length of this cyrtoceroid fragment, forming about $^1/_5$ of a whorl, is 9 mm and its height increases from 2 mm to 3.5 mm. Suture lines can be seen at its ventral side, forming a small saddle. The septa are almost transverse in the adapical part; in the adoral part they slope adorally along the dorsal wall. Ten and a half chambers are present, their

length increasing adorally from 0.6 mm to 0.8 mm. The inner, adapical volution is not shown. There seems, however, to exist a groove along the concave side of the conch, similar to what has been figured by RUEDEMANN (1906, pl. 2, fig. 5), and that has been taken to represent the place of a dorsal siphuncle belonging to the inner volution.

Remarks. There seems to be fairly good accordance between the present specimen and those described by RUEDEMANN (1906, pp. 430—431).

Occurrence. The present specimen was found at the west side of Sjdanovfjellet in the upper part of the Sjdanovfjellet series (foss. loc. no. 12, fig. 1). *Beekmanoceras priscum* has earlier only been known from BRAINARD and SEELY's division D of the Beekmantown limestone near Beekmantown in Clinton County, New York (RUEDEMANN, 1906, p. 399).

Incertae familiae

Bathmoceras? aff. *tennesseense* ULRICH, FOERSTE, MILLER, and UNKLESBAY, 1944

Pl. IV, figs. 4 and 5

1944. *Bathmoceras? tennesseense*, ULRICH, FOERSTE, MILLER, and UNKLESBAY. Spec. Papers. Geol. Soc. Amer. No. 58. P. 130. Pl. 8, figs. 3—8.

Material. Only part of one siphuncle, to which a very small fragment of the phragmocone is adhered, has been found.

Orientation. The side to which the endosiphotube is placed within the siphuncle is here considered to be the dorsal one.

Description. The siphuncle is straight, and a length of 70 mm is represented in this specimen. The adoral cross-section is laterally compressed, its height being 11 mm, and its width 7 mm; the adapical part is less compressed and measures 6 mm across. A somewhat oblique longitudinal section through the adoral end of the sample shows the siphuncle wall as a white, 1 mm to 1.5 mm thick, silicified layer, thickest on the ventral side. A small part of the phragmocone is shown at the ventral side of the siphuncle; the septa are seen as thin, light-coloured walls sloping adorally at an angle of only 30° to the similarly thin light conch wall. The siphuncle lies very close to the ventral side. Mural parts of the septa double the conch wall for more than half of the septal distance. The septal necks have been almost eradicated by recrystallisation so that the details can no longer be seen. On the surface of the siphuncle there are low-pointed rills that represent septal «junctions». They slope adorally from the dorsum to the venter at an angle of about 45°. A broad dorsal lobe contains a low smaller saddle; a ventral saddle that forms an acute angle, is split up by a very acute, spurshaped, little lobe (fig. 8). Thirteen septal «junctions» were counted at a length of 29 mm, giving an average septal distance of 2.4 mm, with very little variation. The septal interior is filled with a dense, brownish grey material, its ventral side containing also dark spots of some material similar to be embedding lime-

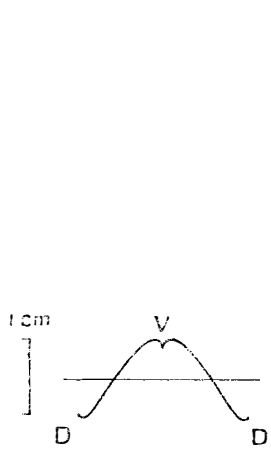

Fig. 8.

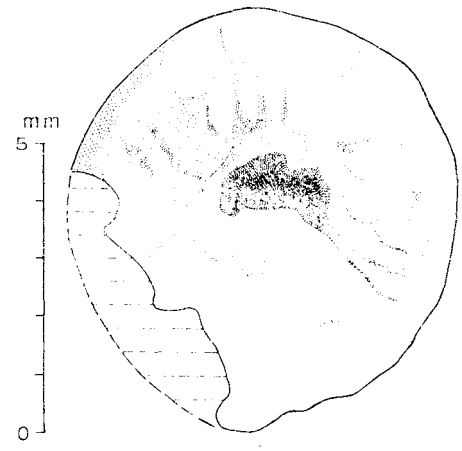

Fig. 9.

Fig. 8. *Bathmoceras?* aff. *tennesseense*. Shape of septal «junction».
Fig. 9. *Bathmoceras?* aff. *tennesseense*. Cross-section through the adapical part.

stone. At 15 mm to 20 mm from its adoral end the siphuncle is intersected by a white, silicified, and about 2 mm thick layer, that slopes 20° adapically to the dorsal side. It is, however, thought to be of inorganic origin.

The septal cavity continues adapically for at least 35 mm, but at 45 mm from the adoral end it has narrowed down to less than 2 mm thickness, forming a pseudoendochon with a lateral apical angle of at least 15°. The thin endosiphotube continues to the adapical end. In a cross-section, 16 mm from the adapical end, it is dorsally planoconvex with pointed lateral flancs. The width of the endosiphotube is 1.5 mm and the height 1 mm, the distance from its center to the dorsal side is 3 mm and from the ventral side 4.5 mm. The remainder of the adapical part of the siphuncle is filled with coarse-grained, light-coloured calcite. It is transversed by wavy, dark diaphragms which extend from the septal «junctions» and slope, like these, adorally from the dorsal side. In cross-section they appear as wavy, broadly horseshoe-shaped lines with dorsal concavity, broadening at the ventral side of the endosiphotube (fig. 9).

Remarks. Except for its marked spur-shaped ventral lobe this specimen shows great resemblance to *Bathmoceras ? tennesseense* ULRICH, FOERSTE, MILLER, and UNKLESBAY, 1944, of the Canadian of Tennessee. Both of them diverge, however, from *Bathmoceras linnarsoni* ANGELIN, 1880, found in the Lower Ordovician of Kinnekulle, Sweden, and thoroughly described by HOLM (1899), in having only wavy transsiphuncular diaphragms instead of the typical coneshaped lobes, and also in lacking the very characteristic ventral saddles. It is therefore very possible that, as soon as some more complete material of similar type can be described, both of them should be removed from the genus *Bathmoceras* BARRANDE, 1865, and placed in a new genus, perhaps even in a separate family.

Occurrence. The present specimen was found close to the southern peak of Hestskanka in the upper part of the Sjdanovfjellet series (foss.loc. no. 11, fig. 1). *Bathmoceras? tennesseense* ULRICH, FOERSTE, MILLER, and UNKLESBAY is described from the Chepultepec dolomite close to Jefferson City, Tennessee.

Order *ENDOCERATIDA* FLOWER, 1950

Family *Piloceratidae* MILLER, 1889

Genus *Cassinoceras* ULRICH and FOERSTE, 1936

Type specimen. *Piloceras explanator* WHITFIELD, 1886, redescribed and designated by ULRICH and FOERSTE (1936).

Cassinoceras sp.

Pl. V, fig. 5

Material. One single fragment of a siphuncle has been found; the adapical and the adoral parts are lacking.

Orientation. The convex side is here considered to be dorsal, and the opposite, almost straight one, to be ventral.

Description. The length of this specimen is 70 mm, the height of the adapical part is 22 mm, increasing to 35 mm in a cross-section 30 mm from the adapical end; the dorsoventral apical angle average 24°, varying from 34° at the adapical part to 11° measured 65 mm adoral to this. The width of the same cross-section is 19 mm, and it increases adorally over a length of 20 mm to 24 mm, giving a lateral apical angle of 14° of the adoral part. The dorsal convex side has a curvature radius of about 120 mm, while the ventral side is straight, except for its somewhat convex adapical end.

Broad annulæ are seen on the surface of the siphuncle, curving moderately from a transverse direction at the dorsal side adorally to the ventral side, with which it forms an angle of 60°—70°, increasing adapically.

The inner part of the siphuncle is strongly recrystallised and silicified, but darker tones seem to indicate 6 or 8 invaginated endocones.

Remarks. The convex dorsal side and the almost straight ventral side, its lateral compression, as well as its broad annulæ are all characteristics of the genus *Cassinoceras* ULRICH and FOERSTE, 1936. Dimensions and shape are in good accordance with the *Piloceras* cf. *explanator* WHITFIELD, 1886, described by HOLTEDAHL (1920B, p. 130) from the Upper dolomite series of Bjørnøya, and compared also with *Piloceras triton* BILLINGS, 1865. Both of these *Piloceras* specimens have later been referred to the genus *Cassinoceras*. The present specimen also shows some resemblance to *Cassinoceras arkansasense* ULRICH, FOERSTE, and MILLER, 1943.

Occurrence. The present specimen was found at the southern part of Wiederfjellet, not far above the sandstones at the base of the Gråkallen series (foss.loc. no. 13, fig. 1). Representatives of *Cassinoceras* have been found in many North American localities as well as in the mentioned strata of Bjørnøya, all of Upper Canadian age.

Genus et species inc.

Material. Two siphuncle fragments have been found, both of them as natural cross-sections, demonstrating several elliptical invaginated endochones, the rest of which are embedded in grey limestone, so that they could only be studied in rock sections.

Description. The length of the best preserved specimen is 25 mm, and its subcircular cross-section measures 24 mm. Six endochones can be seen. Their adoral part have an apical angle of 30°, but adapically they end fairly bluntly around a thin endosiphotube.

Remarks. The preservation does not permit a generic determination of the specimens described, but their strongly widened endocones indicate their belonging to the family *Piloceratidae* MILLER, 1889.

Occurrence. Both specimens were found in the upper part of the Sjdanovfjellet series at the west side of Sjdanovfjellet (foss.loc. no. 12, fig. 1).

Family *Endoceratidae* HYATT, 1884

Genus *Vaginoceras* HYATT, 1884

Type species. *Endoceras multitubulatum* HALL, 1847, renamed and diagnosed by HYATT (1884, p. 266).

Vaginoceras cf. *longissimum* (HALL, 1847)

Pl. IV, fig. 1

1847. *Endoceras longissimum,* HALL. Palæontology of New York. Vol. 1. P. 59, pl. 18, figs. 1, 1a.

1926. *Vaginoceras longissimum,* TROEDSSON. Medd. om Grønland. Vol. 71. P. 25, pl. 3, figs. 1—3.

1941. *Vaginoceras longissimum,* FLOWER. Paleontology of North America. Vol. 3. No. 13. Pp. 66, 67.

Material. Two fragments of the endosiphuncle were found, the larger of which was almost totally enclosed in dark, schistous limestone.

Orientation. The endosiphocoleon is thought to be situated at the dorsal side of the central axis.

Description. The large specimen is 173 mm long and slightly elliptically compressed. In adoral section its height is 22 mm and its width 16 mm; in another section, 80 mm adapical to this, the height is 16 mm and the

width 14 mm, diminishing very slightly further to 15 mm and 13 mm in the adapical end of the sample. Its outer part is formed by a 1—2 mm thick endosipholining of dark-coloured limestone, which is covered by an outer thin, light grey, silicified zone. The interior of the siphuncle contains 6 or 7 almost cylindrical endocones, that are partly incorporated in white siliceous material. They embrace a narrowly compressed, slightly dorsally placed endosiphocoleon, 3 mm high and 1 mm wide, its dorsal side being broader than the ventral one. In one of the cross-sections it can be seen to be supported by a ventral and a dorsal blade, partly destroyed by recrystallisation. At the adoral end the endospihocoleon is continued as an endosiphocone that widens laterally from 1 mm to 5 mm at a length of 50 mm, while its height reaches 9 mm.

Five whitecoloured quartz-filled pseudodiaphragms cut through the endocones at distances of 13 mm, 27 mm, 41 mm, 65 mm, 87 mm, and 115 mm from the adoral end. The pseudodiaphragms do not penetrate the endosiphocoleon or the embedding substance. The distances, which approache multiples of 13 mm, may speak in favour of their being connected with the septa, but the author is more inclined to regard them as having an inorganic origin.

Remarks. The very prolonged septal necks, originally indicated as a characteristic feature of the genus *Vaginoceras* HYATT, 1884, have later been reinterpreted by FOERSTE (1924) and FLOWER (1941, pp. 66—67). The numerous «sheath»-like endocones, as well as the compressed endosiphocoleon supported by two vertical blades, then constitute the only remaining characteristics of this genus. Moreover, the very teretely conical shape of the endocones is taken as a specific character of *Vaginoceras longissimum* (TROEDSSON, 1926, p. 25). It should not be forgotten, however, as pointed out by FLOWER, that the description of the species involved are in most cases based on fragmentarily preserved material, and future research may very likely show that a revision of the Ordovician endoceroids is necessary.

Occurrence. The present two specimens were both found in rock float in the lower part of the thick Lower Ordovician carbonate complex of the Sørkapp Land; the larger of them at the northwest side of Tsjebysjovfjellet, the smaller one at the southeast side of the same mountain, just above a level well marked by masses of Ceratopea specimens (foss.loc. no. 6, fig. 1). *Vaginoceras longissimum* (HALL) has earlier been described from the Black River limestone at Watertown, New York, and also from Cape Calhoun in Greenland. An *Endoceras (Vaginoceras?)* sp. has also been described from Bjørnøya by HOLTEDAHL (1920A, p. 85).

Order *MICHELINOCERATIDA* FLOWER, 1950

Family *Michelinoceratidae*, FLOWER

Genus *Polygrammoceras* FOERSTE, 1927

Type species. *Polygrammoceras twenhofeli* FOERSTE, 1927, as originally designated by the author.

Polygrammoceras? sp.

Pl. IV, figs. 2, 3

Material. One part of one phragmocone has been found.

Orientation. The ventral side is shown by the conchial furrow.

Description. The phragmocone is straight and 56 mm long. In a cross-section 26 mm from the adapical part it is slightly depressed, its height is 6 mm, and its width 7.5 mm. The adoral 20 mm of this specimen is, however, increasingly laterally compressed, so that the adoral section is 10 mm high and 6 mm wide, the ventral part being narrower than the dorsal one. A conchial furrow can be seen in cross-section; on the internal mold of the ventral conch surface it forms a ridge. Longitudinal, flat ribs, separated by narrow furrows are shown, mostly rather faintly, on the naturally weathered part of the surface; their distance is close to 1 mm and their number is estimated at 25—30. Fainter transverse furrows 2 mm apart, as well as narrowly spaced transverse growth lines, can also be seen in some places. Other parts of the surface that are more strongly weathered (or etched by acid to free the specimen from the enclosing rock) show suture lines that slope adorally from the dorsum to the venter. A broad ventral saddle is interrupted in the adoral part by a small, somewhat irregular lobe, that probably represents the former outline of a hyponomic sinus. The septal distance is mostly 3 mm, but diminishes to about 2 mm in the adoral part, thus indicating a gerontic stage (RUEDEMANN, 1921, p. 318). In a sagittal section through the adapical part the septa are shown only as diffuse, dark lines surrounded by light-coloured secondary calcite material. The six most adapical ones are transverse, while a seventh slopes a little adorally to the venter. Septal necks and connecting rings cannot be distinguished. The siphuncle is just a little ventrally placed; its height is 1.5 mm, its width 2 mm. It is filled with structureless dark material.

Remarks. This specimen could well be referred to the genus *Polygrammoceras* FOERSTE, 1927, except for the number of its ribs which seems to be smaller than indicated in the diagnosis of this genus: «If this term be restricted to those species in which the numerous low ribs are flat . . .» (FOERSTE, 1927, p. 363). Its test bears some likeness to that of an *Orthoceras (Kionoceras)* sp. described from the Middle Ordovician Tetradium limestone of Bjørnøya (HOLTEDAHL, 1920A, p. 84, pl. 11, fig. 1). They can be thought to be cogeneric, though the latter is considerably larger and probably younger.

Occurrence. The present specimen was found at the west side of Sjdanovfjellet, close to the top of the Sjdanovfjellet series (foss.loc. no. 12, fig. 1). Several species of *Polygrammoceras* have been described from the Upper Ordovician and the Silurian of the Anticosti Island and of Iowa (FOERSTE, 1927, pp. 263—268 and 1936, p. 242) as well as from the Lower and Middle Ordovician of Sweden and Norway (TROEDSSON, 1932).

Order *ACTINOCERATIDA* FLOWER, 1950

(essentially the Actinoceratidae of FOERSTE and TEICHERT, 1930)

Family *Huroniidae* FOERSTE and TEICHERT, 1930

Genus et species inc.

Pl. V, fig. 3

Material. The only specimen found contains the adapical part of a phragmocone, cut by an oblique longitudinal section, that was ground further down to a more sagittal section. The living chamber is lacking.

Orientation. The siphuncle is here considered to be situated closer to the ventral wall than to the dorsal one.

Description. The length of this specimen is 50 mm; its adoral cross section is elliptically compressed; its height is 7 mm, its width 13 mm, and its apical angle is 11°. Its outer part consists of light-coloured calcite material that is embedded in finer grained, dark material. The surface shows sharp, somewhat irregular ridges, but no true conch shell can be distinguished. There can therefore be some doubt as to whether the whole thickness is represented, or only a calcite deposit around the siphuncle, while the remainder of the chamber (empty), as well as the conch shell, have been destroyed by recrystallisation. The septa can only be seen as obscure dark lines, going almost transversely to the dorsal side, but sloping adorally to the ventral side. The siphuncle is elliptically compressed and bordered by a rather thick, dark limestone zone. Its shape is strongly nummuloidal. The upper septal adnation is found just below the widest part of the nummulæ, the septal necks forming rather flat cones that are narrowly recurved in flat septal rims. The connecting rings are supposed to adhere to the rims where the outer layer is bent backwards. If the parts of the siphuncle wall are correctly interpreted, the free part of the connecting rings are almost equal to the length of the septal necks. In cross-section the broad, dark, limiting zone of the siphuncle sometimes is seen to be split in several separate zones that can well be, however, of inorganic origin. A series of cross-sections shows partly fairly well endosiphuncular cruciform structures, the balks of which are sometimes split in two. They can reasonably be assumed to be endosiphuncular radial canals.

Remarks. The short septal necks and the broadly nummuloidal siphuncle of the specimen are characteristics of the *Huroniidae* FOERSTE and

TEICHERT, 1930, p. 212. The shapes of these features, as well as the cross-section of the siphuncle with its several dark coloured zones are rather similar to *Discoactinoceras multiplexum* as figured by KOBAYASHI, 1927, pp. 200—202, and they may be cogeneric. These similarities shall not, however, here be considered decisive, and less so since the latter was found along with a fauna that seems to be younger than the present one.

Occurrence. The single specimen of this form was found in the Rasstupet limestone about 20 m above a Ceratopea bed at the south side of Tsjebysjovfjellet (foss.loc. no. 7, fig. 1).

Incertae familiae

Material. Three fragments of siphuncles showing actinoceroid endosiphuncular structures (viz. longitudinal ribs) were found in the upper part of the Sjdanovfjellet series. They are all filled with light grey calcite material, partly silicified in particular along their borders, and transversed by dark-coloured diaphragms. Their axial parts are formed by slightly dorsally placed central cylinders, filled with dark material and widened adorally in acute pseudoendocones.

Specimen A. The best preserved specimen (pl. V, fig. 7) is seen clearly in 40 mm length as a very slightly curved cylinder with subcircular cross-section (adorally 10 mm high, and 12 mm wide, adapically 8 mm high and 8 mm wide). Faint narrow ribs are seen on the outer surface, marking the septal «junctions». They slope adorally to the ventral side, and the septal distance is 2.3 mm. In serial cross-sections through a thickness of 3 mm, 6—8 dark-coloured radial ribs could be followed, ramifying in an irregular net pattern at the diaphragm levels. They may reasonably be taken to represent endosiphuncular structures similar to those described from several actinoceroid genera. It was not possible, however, to distinguish any definite curved radial canals comparable to those of the genus *Actinoceras* or other related ones (TEICHERT, 1933, pp. 135—153). The adapical part of this calcite-filled siphuncle seems to continue very obscurely for at least 30 mm in a more strongly curved form. This is a remarkable feature bearing on the peculiar abrupt adapical termination of actinoceroids (TEICHERT, 1934, pp. 13—15), since we here have a case where a seemingly abrupt adapical termination evidently has been caused by a lack of calcite deposition in the adapical part of the siphuncle.

This specimen was found near the southern peak of Hestskanka in the upper part of the Sjdanovfjellet series (foss.loc. no. 11, fig. 1).

Specimen B. One of the two other specimens is rather similar to the former one, its diaphragms showing, however, double or even triple lines in longitudinal section. It is thought to be closely related to the former one. It was found on the west side of Sjdanovfjellet in the upper part of the Sjdanovfjellet series (foss.loc. no. 12, fig. 1).

Specimen C. The third specimen, found at the same locality, along with the two earlier mentioned *Oneotoceras* specimens, is somewhat thicker (11 mm—15 mm across), and its central canal is broader, showing narrow, acute ribs in cross section. The continuation of these longitudinal ribs is less well shown in the surrounding light grey calcite material. Traces of exosiphuncular features are seen, though almost obliterated by recrystallisation. The septal distance is 25 mm—30 mm, and the length of the presumed septal neck is 1 mm—1.5 mm. This resembles the early actinoceroid *Polydesmidae* forms (TEICHERT, 1937, p. 710—712), but neither this, nor the former two specimens, can be determined without much better material.

Remarks on the fauna.

The cephalopods described in this part represent, to all probability, but scarce remnants of a much more abundant fauna, the greater part of which having been destroyed by rock deformation and recrystallisation.

Six of the forms are comparable to species described from the Lower Ordovician (Canadian) of the American-Arctic fauna province: *Cassinoceras explanator* (or other *C.* species), *Protocycloceras lamarcki, Protocycloceras arkansasense, Oneotoceras loculosum, Beekmanoceras priscum,* and *Bathmoceras ? tennesseense*. The genus *Cassinoceras* is represented only in strata of upper Canadian age, though fairly wide-spread in the Ozark Region and the Appalachian Highlands as far north as to New Foundland, and also in the Younger dolomite series of Bjørnøya (Bear Island) (ULRICH, FOERSTE, and MILLER, 1943, p. 35). *Protocycloceras lamarcki* has also been described from strata of Canadian age of the same regions (including Bjørnøya) and also from Greenland. It seems, however, to have had a somewhat wider vertical range, covering the greater part of the Canadian age. *Oneotoceras loculosum* has been found in strata of lower Canadian age at several localities of the Ozark Region and the Southern Appalachian Highlands, very distant, however, from its possible Spitsbergen occurrence. The other three of the six species mentioned have been described earlier from but one locality each, and they are, therefore, of less use for stratigraphic correlation with the Spitsbergen area. The remainder of the cephalopods described in this paper, *Vaginoceras* cf. *longissimum, Polygrammoceras ?* sp., and the actinoceroid specimens, would most likely be supposed to be younger than the Canadian age. The determination of these forms is, however, not very satisfactory, and their occurrence should not be given too much weight until more and better material is available.

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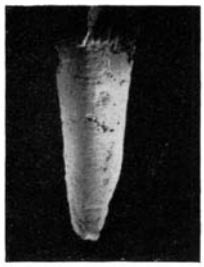
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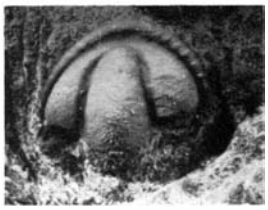
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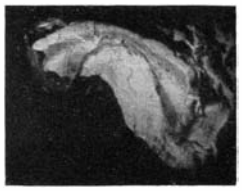

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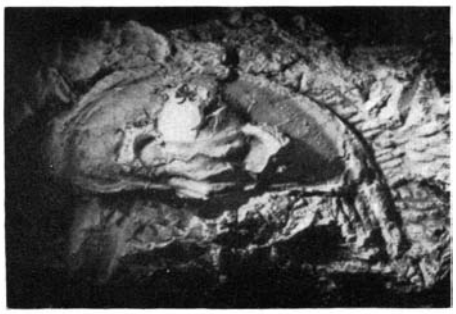

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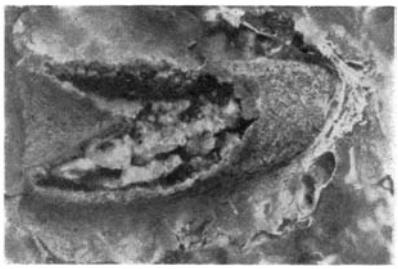
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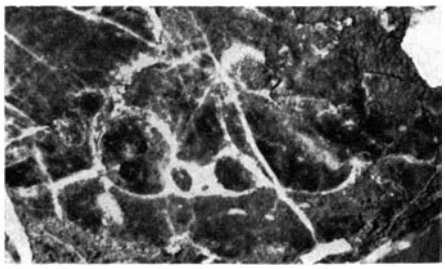
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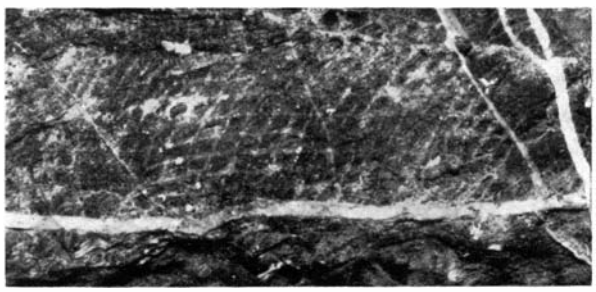

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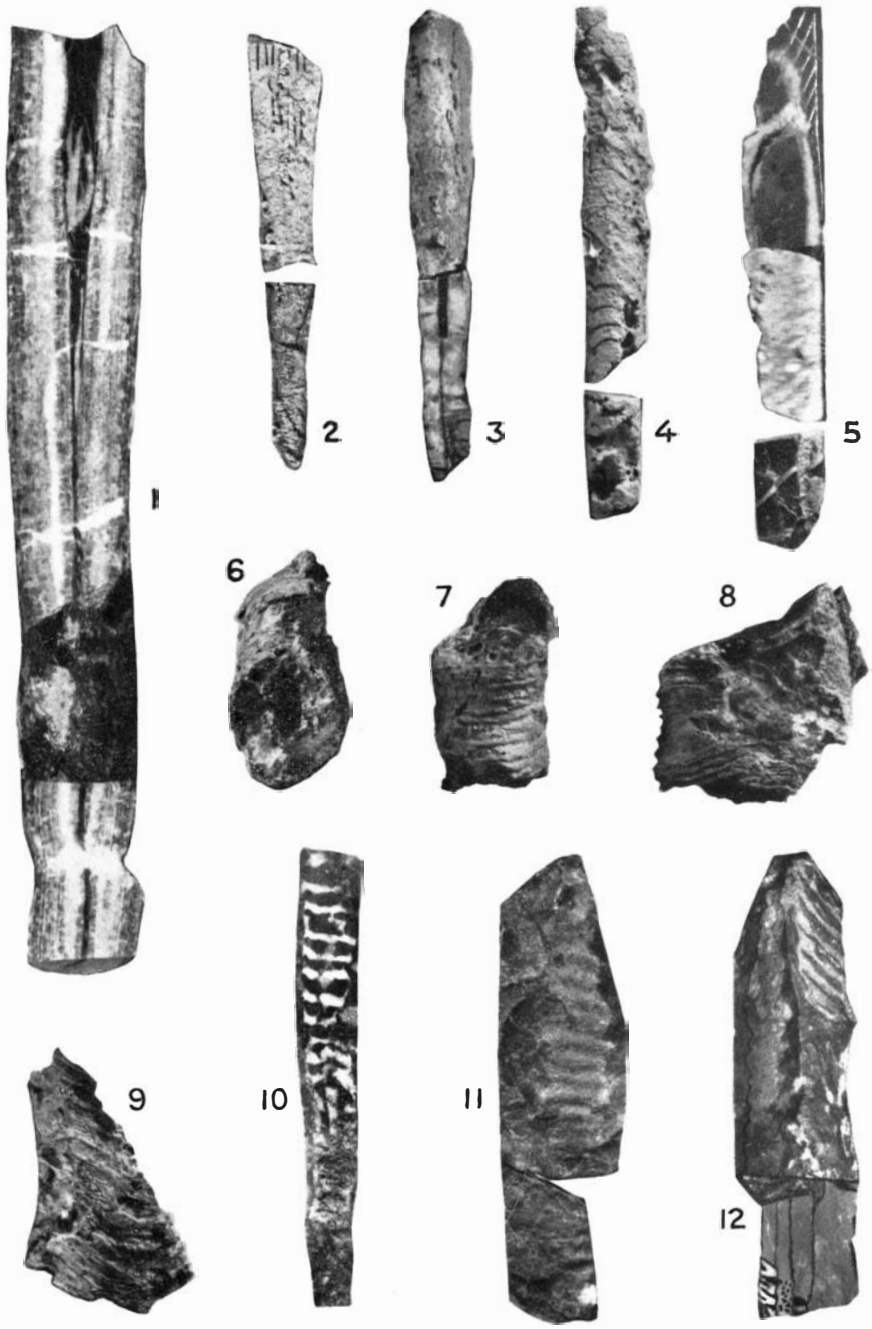
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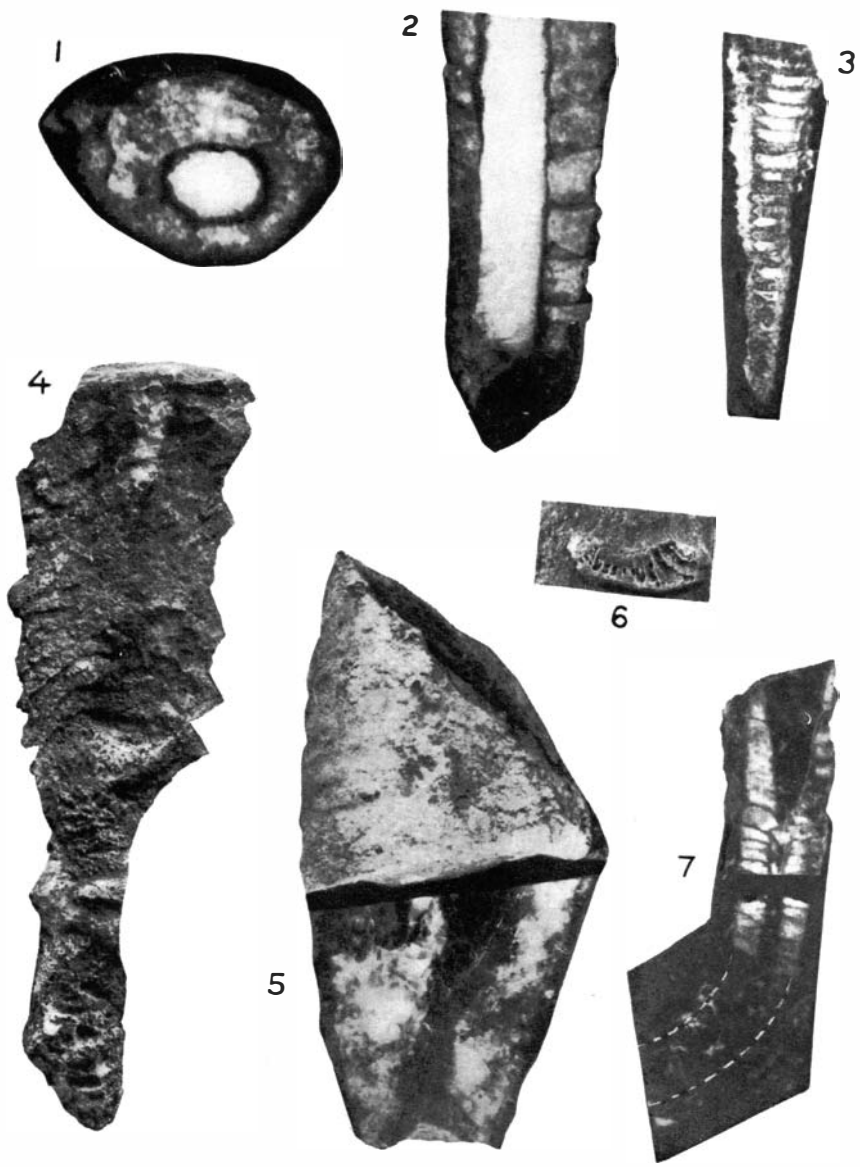
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MAPS AND CHARTS

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Preliminary topographical maps [1:50000] covering claims to land in Svalbard and a preliminary map of Hopen 1:100000 may be obtained separately.

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