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SER. C. Avhandlingar och uppsatser. N:o 314.

ÅRSBOK 16 (1922) N:o 4.

REMARKS ON SOME FOSSILS FROM THE DIAMOND BORING AT THE VISBY CEMENT FACTORY

PRELIMINARY REPORT

BY

HERMAN HEDSTRÖM

(WITH TWO PLATES)

Pris 1,00 kr.

STOCKHOLM 1923
KUNGL. BOKTRYCKERIET. P. A. NORSTEDT & SÖNER
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In another paper I have already mentioned the discovery of *Mobergella Holsti* (MBG.)[1] in the core from the diamond boring at the Visby Cement Factory. I shall now proceed to give a short, preliminary communication of some other fossils encountered in the lower parts of the core, and of which, until now, I have been unable to have any figures ready. Mr GEORG LILJEVALL has examined each portion of the core for possible fossils with his usual care and exactness, but the drawing and description of the whole of the material is not yet finished.

This deep boring through the whole of the Cambro-Silurian lying below the sea-level at Visby, in the Island of Gothland, was carried out in 1911 and the beginning of 1912, at the marl pit of the Visby Cement Factory, and formed a direct continuation of a boring the Company had made for the purpose of discovering the character of the rock lying immediately beneath the bottom of the pit. Fig. 1 shows the position of the drill hole at the bottom of the marl pit. The boring went on, with a number of stoppages until, at a depth of 383 m from the mouth of the drill hole (lying 4.6 m below the level of the sea), gneiss was encountered; the boring being continued in this rock for a further 20 m.

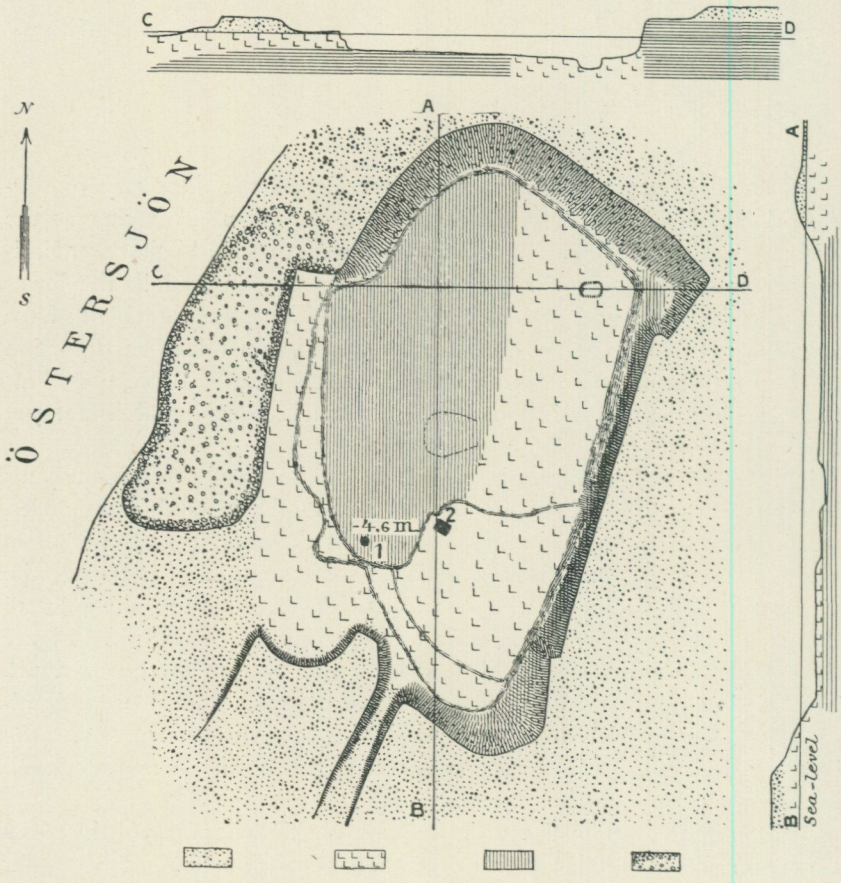
The profile given in fig. 2 shows roughly the character of the rocks encountered, as well as their percentage of calcium carbonate, as far as they have hitherto been analysed.

It is the fossils of the lowest 150 m that have been examined. The material from the upper strata is, in part, fairly rich, but it has not as yet been dealt with.

It is evident that it is almost a matter of mere chance if distinct and determinable fossil fragments are met with in a core with a diameter of not more than 21 mm. As a rule, it is only parts of fossils that have been obtained, and a detailed acquaintance of the whole of the Cambro-Silurian fauna is required to be able to determine the

[1] HEDSTRÖM, HERMAN: On »*Discinella Holsti* MBG.» and *Scapha antiquissima* (MARKL.) of the division Patellacea. — S. G. U. Ser. C. N:o 313.

genus and species of a small part of these fragments. Sometimes it is only a part of a trilobite-pleura; in other instances, a more or less damaged brachiopod shell, and so on. One group, of which one had



1. Mouth of the diamond drill hole.
2. Aerial rope way station.
Sea level about $^1/_4$ m above normal height of the water.

Fig. 1. *Map of the marl pit of the Visby Cement Factory Co's works.*
by C. W. PEDERSÉN $^{23}/_9$ 1911.
Scale 1 : 2 000. Heigt and length scale the same.

reason to expect to find determinable specimens, were the small ostracods, but, to be able to identify them, the assistance of a monograph would have been necessary, dealing with the various genera

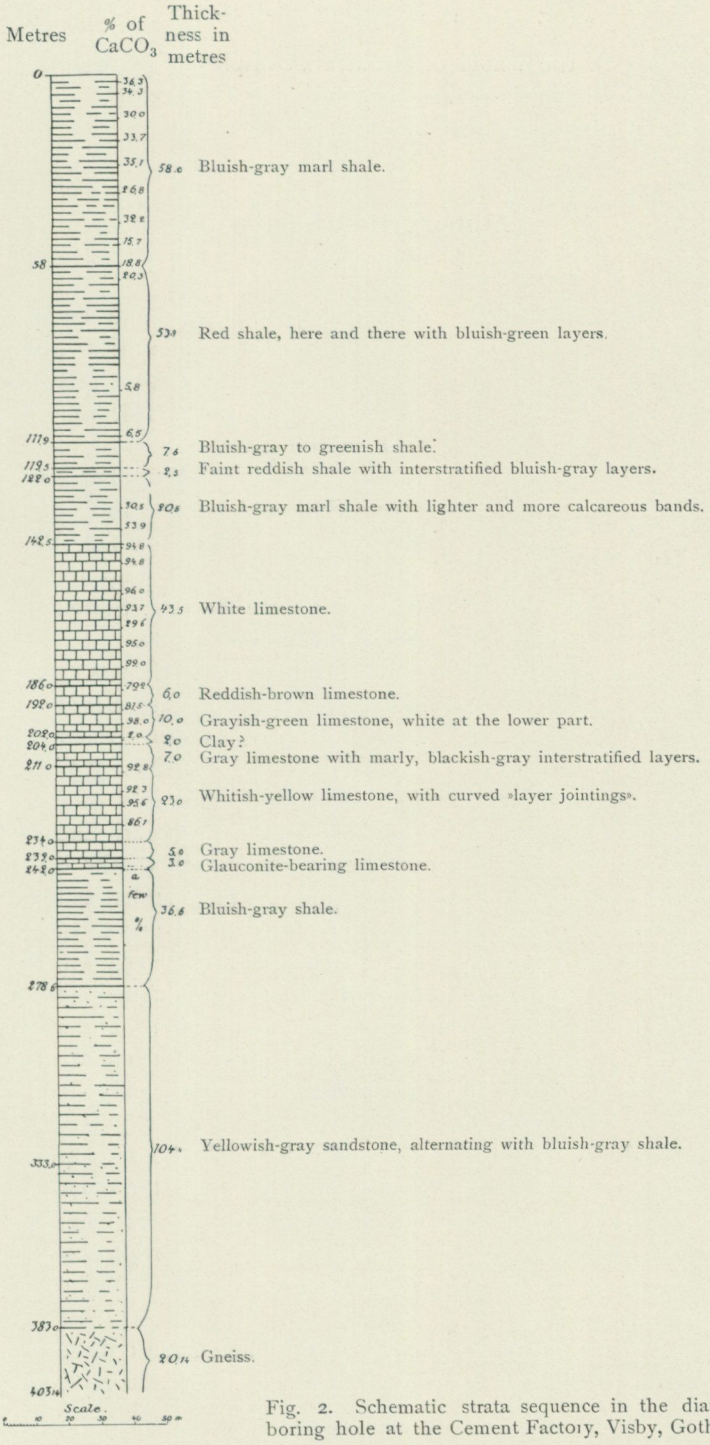


Fig. 2. Schematic strata sequence in the diamond boring hole at the Cement Factory, Visby, Gothland.

†—230744. *S. G. U., Ser. C, n:r 314, Hedström.*

and species in the whole of the strata-complex of the Cambro-Silurian system, and such a monograph simply does not exist.

The first fossil met with in the cores is:

Mobergella Holsti (MBG.)

Plate I. Fig. 1—3.

1892. *Discinella Holsti.* MOBERG, JOH. CHR.: Om en nyupptäckt fauna i block av kambrisk sandsten. — S. G. U. Ser. C. No. 125. Also published in Geol. För. Förh. Bd. 14. 1892. Fig. 1—8 in the plate.

1902. » » WIMAN, CARL: Studien über das nordbaltische Silurgebiet I. — Bull. of the Geol. Inst. of Upsala. No. 2, Vol. VI. Part 1. 1902. P. 55. Pl. II. Fig. 10.

1906. » » WIMAN. CARL: S. G. U. Serie A 1 a No. 5. Descriptive text. P. 89.

1922. *Mobergella Holsti.* (MBG.). HEDSTRÖM, HERMAN: On »*Discinella Holsti* MBG.» and *Scapha antiquissima* (MARKL.) of the division Patellacea. — S. G. U. Ser. C. No. 313.

Three more or less broken shells and a number of fragments of this gastropod, with its phosphate, mother-of-pearl like shell, have been encountered at a depth, below the mouth of the drill hole, of about 333 m, or 50 m above the gneiss which underlies the Cambro-Silurian strata. The specimens were, actually, found in the »core portion No. 179», obtained from a depth of $331{,}_{57}$—$334{,}_{27}$ m below the mouth of the drill hole. They all lie in a finegrained sandstone with small scattered dark-green grains of glauconite. The sandstone is composed of grains of gray quartz and glauconite, about 1 mm in dimension, lying in a white, crystalline mass which only here and there effervesces with hydrochloric acid.

Fig. 1 shows the inside of an old individual, about $3{,}_5$ mm in length. The top of the shell is viewed from below, and the muscular impressions grouped round about it, of which the 6 of the one side — that farthest back being just visible — are clearly conspicuous, while the impressions of one or two of the foremost of the other side can also be caught sight of.

Fig. 2 is the posterior part of a shell, and shows the upper side of an internal shell-layer, on which there are visible several ridges corres-

ponding to the grooves on the inside of the shell. Cf. with this, for example, *Moberg's* Fig. 5 in the paper referred to.

Fig. 3 is a fragment of the upper side of the shell.

Undeterminable Specimen.

Plate I. Fig. 4.

From the same »core-portion No. 179». i. e., from a depth of about 333 m below the mouth of the drill hole, or about 50 m above the gneiss, we find a little brown shell 1 mm in length. The apex and one side are damaged, this rendering an exact determination impossible. On the part preserved there is a concentric striation and very faint signs of fine radiating striae. Differing from the former shell, this latter is imbedded in a blue-gray, fine-grained shale, a rock which, according to the testimony of the cores, alternates with the sandstone. — Possibly it is to be considered as a *Mobergella*.

Undeterminable non-articulate Brachiopod.

Plate I. Fig. 5.

From »portion No. 178», or 329,27—331,57 m below the mouth of the drill-hole, there was obtained a shell-fragment of a brachiopod. It is brown in colour, has a concentric structure and has, most probably, been at least 1 cm in diameter. The rock in which it was discovered is a sandstone of approximately the same character as that in which *Mobergella* was found, but it contains fragments, one cm in size, of a black, phosphoritic mass. The embedding mass is non-calcareous.

Obolus (Westonia) n. sp.?

Plate I. Fig. 6.

Locality: The deep-boring hole at the Visby Cement Factory, Gothland. »Core-portion No. 157», 271,74—273,56 m below the mouth of the drill hole. The rock is a greenish-gray, non-calcareous shale.

For the present, this fossil has been classified as a n. sp. With regard to its appearance it resembles *Obolus* (*Westonia*) *finlandensis* WALCOTT,[1] and the other two considered by WALCOTT as special

[1] WALCOTT, CHARLES D.: Cambrian Brachiopoda. — U. S. Geol. Surv. Monographs Vol. LI. pp. 462 (454, 467). Plate XLVIII, fig. 3, 3 a—b; fig. 4, 4 a—c; fig. 5, 5 a—b. — Cf. also p. 451 and the said plate fig. 6, 6 a; fig. 7, 7 a—b.

species, viz., *Obolus* (*Westonia*) *bottnicus* (WIMAN) and *O.* (*W.*) *Wimani* WALCOTT, which may be suspected to be one and the same species.

The present specimen, however, is only provided with concentric lines of growth and a very fine radial striation, and does not in difference to the above named species possess the »series of imbricating lines that are slightly oblique to the longitudinal axis of the shell» and »terminate at right angles to the margins, curving inward and backward apparently to the opposite side», »like that of several species of *Westonia*, except that it is more complicated.»

The shell found is a ventral one and, in the main, agrees in form with the species mentioned. The length of the shell appears to have been about 1 cm and the greatest breadth 6—7 mm. In addition to the above-mentioned sculpture (concentric lines of growth and, between these, clearly visible although very fine radial striation), there can be seen on the shell surface about 4 rather dark impressed lines running in a longitudinal direction and which, possibly, are to be regarded as marks, visible on the surface of the shell, of the internal character.

Extensive material is required for a detailed examination of the above-mentioned forms, for one or two other species appear to be closely allied to them, viz., *O.* (*W.*) *ålandensis* WALCOTT, and *balticus* WALCOTT.

Unknown Fossil.

Plate I. Fig. 7 a, b and c.

Locality: The deep-boring hole at the Visby Cement Factory, Gothland. »Core-portion No. 155», 268,29—269,90 m below the mouth of the drill hole. The rock is a greenish-gray shale.

Between two layers there was found a flat thorn-shaped fossil with a visible breadth of 4 mm and a length of 18 mm, and of an iron-ochre colour. It has the shape of a slightly curved and gradually narrowing flat thorn, provided on both sides with a rather characteristic, slightly projecting limb, the breadth of which is about $^1/_4$ mm. As may be seen from Fig. 7 b and 7 c, the limb is provided with oblique furrows running across it, and which run obliquely from the margin inwards-outwards, on the one side of the fossil while, on the opposite side, they go in the reverse direction, viz., from the margin obliquely upwards towards the broader part of the »thorn.»

The impression of the shell in the stone appears like brown, patchy, membraneous fragments (Fig. 7 b, in the outer part of the »thorn»).

Acrotreta uplandica WIMAN.

Plate I. Fig. 8 a and b. — Fig. 9 a and b. — Fig. 10 a and b.

Acrotreta uplandica WIMAN. — WIMAN, CARL: Studien über das nordbaltische Silurgebiet 1. — Bull. of the Geol. Inst. of Upsala, No. 2, Vol. VI. Part 1. 1902, p. 54. Pl. 11. Fig. 15—18.

» » » WALCOTT, CHARLES D.: Cambrian Brachiopoda. — U. S. Geol. Survey. Monographs. Vol. LI. P. 714. Pl. LXX. Fig. 3, 3 a—c.

Locality: The deep-boring hole at the Visby Cement Factory, Gothland. »Core-portion No. 154». $266{,}60$—$268{,}29$ m below the mouth of the drill hole (Specimen Fig. 8). The rock a greenish-gray non-calcareous shale. — »Core-portion No. 145». $248{,}63$—$252{,}02$ m below the mouth of the drill hole (Specimens Fig. 9 and 10). The rock is a fine-grained gray limestone.

The two ventral shells found (Fig. 8 and 9) agree best with the species named above, especially if we take into consideration the fact that, in consequence of pressure, the individual shown in Fig. 8 has been made flatter than it was originally. It has cracked around the outer portion and the margin has thereby been pressed up into a higher plane. Otherwise one would rather be inclined to assign this shell to *A. uplandica limöensis* (WIMAN) — see the above-mentioned papers — the height of which is only $^1/_3$ of the diameter.

As regards the proportion between height and diameter, the two specimens found lie between the main species and the variety, i.e., the height is more than $^1/_3$, and less than $^1/_2$, of the greatest diameter. Otherwise, they agree best with *A. uplandica* WIMAN (with excentric apex and rounded area). In the specimen shown in Fig. 9, the apex is wanting.

On the same layer-surface as that illustrated by Fig. 9, there lies a dorsal shell, shown in Fig. 10 which, it seems to me, can be referred to this species. It is of the same length (2 mm) as *A. uplandica* WIMAN (Fig. 9), but, at the apex, there are two small prominences. When one is dealing with the *dorsal shells* of the nearly related genus *Acrotreta* and *Acrothele* it is difficult to determine genus and species, especially as the inner characteristics are not accessible, and as forms of both genera belong to approximately the same level in the Cambrian series of strata.

All the shells are brown in colour and are marked by fine, concentric striation.

»Core-portion No. 149». The following three fossils were found at a depth of 259,07—260,63 m below the mouth of the drill hole (i.e., about 122,4—124 m above the underlying gneiss).

Acrotreta sp.

Plate I. Fig. 11 and 12.

I have referred to this genus a couple of dorsal shells which could not be more definately determined. The shells are brown in colour, with lighter and darker concentric bands following the lines and ridges of growth. The posterior margin is rather straight. The lines of growth sometimes appear to have been pressed inwards, whereby their vertical section appears as a softly curved line. On the one shell the tubercles are scarcely visible and the shell appears to finish in an elevated apex. Both the shells are a little wrinkled between the lines of growth. They were found in a grayish-green, non-calcareous shale.

Paradoxides sp. (Fragment of a free cheek).

Plate II. Fig. 1.

It is impossible satisfactorily to assign this fragmentary free cheek with genal spine to any definite species. — The rock was a grayish-green, non-calcareous shale.

Acrothele (Redlichella) granulata (LINNARSSON).

Pl. I. Fig. 14 a—c.

Literature: LINNARSSON, G.: On the Brachiopoda of the Paradoxides beds of Sweden. — Bih. K. Sv. Akad. Handl., Bd 3, No. 24. Pl. IV. Fig. 51, 52. — Stockholm 1876.

» » Om faunan i lagren med Paradoxides Ölandicus. G. F. F. Bd 3. P. 373. Pl. 15. Fig. 12. — Also printed in S. G. U. Ser. C. No. 22. — Stockholm 1877.

WALCOTT, CHARLES D.: Cambrian Brachiopoda. — U. S. Geol. Survey. Monographs. Vol. LVI. P. 663. Fig. 2, 2 a—n. (Here there is, too, a more exhaustive list of literature).

Fragment of a dorsal shell which, on account of proportions, character and sculpture, must be assigned to this species, in good agreement with the species-characteristics given by LINNARSSON, especially Fig. 51 b in his first paper (and WALCOTT). From the posterior margin to the middle, there runs a »well-marked (very distinctive) depression» which was observed by LINNARSSON on the inner cast. The sculpture exhibits wrinkled granulated lines of growth. The shell lies in a non-calcareous, grayish-green shale.

The shell exhibits a complete agreement with the numerous specimens found in the excavations in the Cambrian strata at Ödegården, parish of Hvarf, Västergötland, made in 1907 at the instance of the Geological Survey of Sweden, material which remains still unexamined among the collections of the Survey. The classification of LINNARSSON's dorsal shell from Borgholm is questionable.

»Core-portion No. 148». 256,89—259,07 m below the mouth of the bore hole. The rock is a greenish-gray, non-calcareous shale. From here is only found the following fossil.

Acrotreta sp.

Pl. I. Fig. 13 a and b.

It is only with great hesitation that I refer the ventral shell discovered to this genus. It is very defective, but it has distinct, concentric lines of growth. On the sides of the apex a couple of small tubercles can be discerned on the impression, and between them a faint furrow. The part lying beyond this is destroyed.

Respecting *Acrotreta uplandica* WIMAN, from »core-portion No. 145» (Fig. 9 and 10) see P. 9, above. The rock, in this instance, is a gray limestone.

»Core-portion No. 143». Between 244,68 and 245,80 m below the mouth of the drill-hole. The rock is a gray non-calcareous shale.

Paradoxides Sjögreni LNRS.

Plate II. Fig. 2.

Literature: LINNARSSON, G.: Om faunan i lagren med Paradoxides Ölandicus. S. G. U. Ser. c. No. 22. P. 6. Pl. 1, Fig. 1—6.

GRÖNWALL, KARL A.: Bornholms Paradoxides-lag og deras fauna. The Geol. Surv. of Denmark. Række II. No. 13. Pp. 118, 119. Pl. 2. Fig. 8.

A compressed mould, found in the shale, of the cranidium of a trilobite, is very closely related to the above species. The neck ring it broadest in the middle. The neck-furrow passes right across the head. The posterior glabella-furrow (= »the third anterior pair of furrows») goes across the glabella, and, in the middle of this, curves backward, where it is shallowest. In front of this there lies (in consequence of the compression?), a continous furrow (= »the second anterior pair of furrows»), which also curves slightly backwards in the middle; this furrow is most deeply impressed on the sides of the glabella. Finally, there is visible in front of this, a *faint* shade of furrows (= »the foremost pair»), which do not run together dorsally but seem to have formed a *pair*. The glabella is pear-shaped; its anterior edge approaches so near to the limb as almost to touch it.

Judging by LINNARSON's figures (e.g., Fig. 10), the glabella in his specimens does not extend so far forwards. From the palpebral lobe in my specimen the facial suture runs in a straight line obliquely forwards-outwards to the anterior margin of the limb, and is not directed so far outwards as in the variety distinguished as *Paradoxides nepos* GRÖNW. (GRÖNWALL, above-cited work, Pl. 2, Fig. 8). The palpebral lobe is longer in his specimen, and extends farther back, from which follows that the eye here must have been larger than in LINNARSSON's original specimens.

These small differences may possibly be sufficient to allow of the creation of a new variety for which, in such a case, I propose the name of var. *balticus*.

The *Paradoxides* sp. figured by WIMAN from the north Baltic district is too fragmentary to allow of a comparison.

»Core-portion No. 142», from a depth of 241,53—244,08 m below the mouth of the drill hole, and thus, in its upper part, belonging to that bed of the glauconite limestone bordering against the underlying shale, is, from a stratigraphic point of view, an important part of the core, and has, consequently, been thoroughly examined for fossils. Like some other core portions, it has, therefore, been devided into 16 consecutive parts, which have been numbered from below upwards (from 142,1 to 142,16). Beginning from below, then, there have been obtained the following fossils worth mentioning. Fragment of trilobite-pleurae have been found in almost every extracted part.

Solenopleura? sp.

Pl. II. Fig, 3.

In gray, non-calcareous shale (»core-portion 142,2»), there was found a cast (partially with shell fragments still attached) of the cranidium of a trilobite, the state of preservation of which however, does not permit of detailed determination, but it seems, has not been known before.

Apparently, it is nearly related to the genus *Solenopleura*, but no facial list is visible. The fixed cheek is broad and forms an arc towards the anterior margin of the glabella. Between the glabella and the fixed cheek there is a furrow. No palpebral lobes are visible. The neck-ring is narrow and separated from the glabella by a distinctly visible furrow.

The glabella is the part that is best preserved; it is of almost constant breadth, rounded anteriorly, and is provided with four evident pairs of furrows. The posterior pair are clearest seen, and are connected across the side of the glabella, where it forms a broad bulging backward. The following three pairs are visible only on the sides of the glabella, and each pair does not meet on the back of the glabella. They lie almost at right angles to the furrow running between the glabella and the fixed cheek.

Anomocare balticum n. sp.

Pl. II. Fig. 4.

The following literature has been consulted for comparison with *Anomocare laeve* ANG.: ANGELIN, H. P.: Palæontologia Scandinavica Stockholm, 1878. P. 25, Pl. XVIII. Fig. 1. — GRÖNWALL, KARL A.: Bornholms Paradoxides-lag og deres Fauna. — Geol. Surv. of Denmark. Række II. No. 13. P. 141. Pl. 4. Fig. 8, 9.

An almost entire, small cranidium of a young specimen has been found in »part 4 of core-portion 142». The rock is a gray shale. The species is nearest to *A. laeve* ANG., but his characteristics for this are very incomplete. GRÖNWALL has made use of this name for specimens found by him in the island of Bornholm (S. Baltic) but, compared with his, the specimen in question presents quite a number of essential variations, so that I state it as a new species.

The cranidium is almost square, being as broad as long. The glabella is as broad anteriorly as it is posteriorly. The field between the glabella, the facial list and the limb is narrower than in GRÖN-

WALL's specimen (Fig. 8); the limb is narrow. A narrow elevated list runs between the foremost part of the glabella and the limb. The three pairs of glabella furrows are in better agreement with his *A. laeve* ANG.; the rearmost pair runs obliquely in on the glabella, but the foremost pair, on the other hand, is more deeply impressed and runs almost at right angles to the furrow lying between the glabella and the fixed cheek; none of the furrows reach the central line of the glabella. The arc that is formed of the palpebral lobe and the facial list is, in the present specimen, more bent anteriorly, and is not almost straight as is the case of those from Bornholm. The facial suture runs from the limb more directly backwards.

Ellipsocephalus polytomus LNRS.

Pl. II. Fig. 5 and 7.

Literature: LINNARSSON, G.: Om faunan i lagren med Paradoxides Ölandicus. — G. F. F. Bd. 3. P. 363. Pl. 15, Fig. 1.

WIMAN, KARL: Studien über das nordbaltische Silurgebiet 1. — Bull. of the Geol. Inst. of Upsala. No. 2. Vol. VI. Part. 1. 1902. Pp. 44, 45, Pl. 1, Fig. 22—24.

A fragment of the right posterior part of a cranidium (Fig. 5) was found in gray non-calcareous shale (»core-portion $142_{,9}$»). The specimen has no trace of neck-furrow, and, consequently, should be referred to *E. Hoffi* SCHLOTH., but, immediately above, in »core-portion $142_{,10}$» there was found another fragment of the same part, showing signs of a neck-furrow (Fig. 7), and as the two specimens certainly belong to the same species, it will probably be most correct to consider them merely as a form-variation of the furrowed *E. polytomus* LNRS. The cranidium being so fragmentary it is impossible to make any detailed comparison between the present species and *E. latus* WIMAN.

Strenuella subgotlandica n. sp.

Pl. II, Fig. 6 a, b and c.

For comparison with the nearly related species: *Strenuella primaeva* BRØGGER, *Str. Linnarssoni* KIÆR, and *S.* (*Axionellus*) *baltica* WIMAN, we refer to following literature: KIÆR, J.: The Lower Cambrian Holmia Fauna at Tomten in Norway. — Videnskapsselsk.

Skrifter. Christiania. 1916. II. P. 31—41, Pl. IV, Fig. 1—6. Pl. V, Fig. 1—10. (He gives, here, some of the older literature). — LINNARSSON, G.: De undre Paradoxideslagren vid Andrarum. — S. G. U. Ser. C, No. 54. P. 21. Pl. IV, Fig. 3 and 4. Stockholm, 1883. — MOBERG, JOH. CHR.: Bidrag till kännedomen om de kambriska lagren vid Torneträsk. — Stockholm. 1908. S. G. U. Ser. C. No. 212. P. 26. Pl. 1. Fig. 1—5. WIMAN, CARL: Studien über das nordbaltische Silurgebiet 1. Bull. of the Geol. Inst. of Upsala. No. 2. Vol. VI. Part 1. P. 44. Pl. 1, Fig. 17—21.

Of the three above-mentioned 3 species, the present specimen appears to be nearest related to *Str. baltica* WIM., but differs from it by the arched part in front of the glabella being shorter. (Cfr Fig. 6 a and 6 c with WIMAN'S Fig. 18 and 20). The curved furrows in front of the palpebral lobes reach the glabella farther behind its front part, the palpebral lobes, which, on the sides, are bent somewhat upwards (Fig. 6 b), project farther to the sides at their hinderpart, thereby giving the facial suture another form. The cranidium is widest across the lateral segment of the neck ring. — No lateral furrows are visible on the glabella, which prevents a comparison with *Str. Linnarssoni* KIÆR in this respect, but that species appears to differ from the specimen now in question by the form of the arched part in front of the glabella (Cf. KIÆR'S Fig. 5 a on Pl. IV), and its other general characteristics.

The cranidium of the head is found in »Part 10 of core-portion No. 142», i. e., within the same horizon as the preceding species. The rock is a gray shale.

Free cheeks of trilobites.

Pl. II, Fig. 8 and 9.

In »part 14 of core-portion No. 142», there were found several free cheeks of trilobites, which it was impossible to determine with any definiteness. Two of them are figured here. Two different forms of pleurae were also found. The rock is a gray shale, in part with rather hard bands.

Species 1, Fig. 8, is a right cheek viewed *from above*. It presents a large convexity for the eye, which, consequently, has been large; on the sides it is provided with fine, terrace-like lines, which follow the margin, but its most prominent characteristic is a projecting corner on the side. The shape is shown by the figure.

Species 2, Fig. 9, is the *inner* side of another right cheek, this, too, appertaining to a trilobite with large eyes. On the side there

projects here from the cheek a short, backward-outward directed spine. Similar convexities and spines on the sides of the cheeks are known in the case of several species (Cf. e. g. *Paradoxides inflatus* CORD. Pl. 13, Fig. 16, in BARRANDES': Système silurien du centre de la Bohême, 1 Partie, Vol. 1, Planches, Prague, 1852 and *Vanuxemella contractor* WALCOTT in WALCOTT'S Paper: Cambrian Geology and Palaeontology III. No. 3, Cambrian trilobites. — Smithsonian Miscellaneous Collections. Vol. 64. No. 3. P. 221. Pl. 36, Fig. 4). Without any other guide than the free cheek, it is impossible to determine the species, especially as similar species have not been previously mentioned from Sweden.

In the uppermost part of »core-portion No. 142», the shale becomes rich in pyrite and harder parts, and in the core taken from just above that core-portion, there is found a layer of gray, flint-hard, dense limestone, which upwards passes into a flamy-yellow, rather dense limestone with grains of green and yellow glauconite.

In »part 3 of core-portion 141», i. e., 239,25—241,53 m below the mouth of the drill-hole, there have been found fragments of a number of different fossils, pointing to the existence of quite another and richer fauna. Among these may be mentioned: *Orthoceras*, *Bellerophon*, small ostracods and parts of brachiopods. Among the latter, there is an entire dorsal shell of an *Eoorthis*, to which I have given the name of:

Eoorthis baltica n. sp.

Pl. II, Fig. 10.

The shell much resembles *Eoorthis remnica sulcata* (WALCOTT) (v. WALCOTT, CHARLES, D.: Cambrian Brachiopoda. U. S. Geol. Survey. Monographs. Vol. LI. P. 787. Pl. XCII. Fig. 1 b), which shell originates from the Upper Cambrian Sandstone, Winfield, Jefferson County, Wisconsin. It has a straight hinge line, is about 2,6 mm broad, and 1,8 mm long along the sides of the central furrow. From the anterior margin, the shell is widely emarginate even to $^1/_3$ of its length, to which emargination there runs a furrow from the apex. Between this furrow, i. e., the notching of the shell, and the posterior margin of the shell, there can be reckoned 6 radiating striae on each side. In the American specimen, which is larger, these lines are more than 10 in number, and the furrow is not so deep.

The next core upwards in the strata series, »core-portion No. 140», consists of a gray, fairly dense limestone with yellow grains of glauconite and with dots in some parts of it. The core-portion is from a depth of $233{,}64$—$239{,}25$ m below the mouth of the drill-hole, i. e., its height above the lowest limit of the Cambrian strata is, in round numbers, from 144 to 149 m. In this core-portion there have been encountered small ostracodes and fragments of trilobites, among the best preserved fragments of which latter may be mentioned:

Cheirurus sp.

Pl. II, Fig. 11.

A part of a thorax-segment with axis and the immediately proximate parts of the right pleura. Although fragmentary, this thoracic segment can be assigned with certainty as belonging to a species of *Cheirurus*. It was obtained from part 6 of the above-mentioned core-portion, counting from the lower end.

Remopleurides dorsospinifer PORTL.

Pl. II, Fig. 12, 13 a—c and 14.

Syn. *Remopleurides dorsospinifer* PORTL. — Geol. Rep. Vol. 1, Fig. 3.
» » SALT. — Mem. Geol. Surv.; Dec. VII; Vol. VIII, Fig. 3, 4.
» » LNRS. — Om Vestergötlands cambriska och siluriska avlagringar. — Kungl. Sv. Vet. Akad. Handl. Vol. 8. No. 2 P. 68. Fig. 23, 25. Stockholm, 1867.

Of this species, 5 more or less entire cranidia have been found in part 7 of the same »core-portion», in addition to a broken hypostoma, which must, in all probability, be assigned to the same species. A part of a thorax-segment comes from part 8, lying immediately above.

The cranidium, of which figures are given here of the most entire specimen (Fig. 13), agree in form and characteristics with LINNARSSON's description. The breadth of the glabella is greater than the length, even if the tongue-shaped prolongation be included in the latter, and the glabella narrows off more evenly towards the front

than in *R. radians* BARR. On the glabella, there are visible 3 pairs of lateral furrows, which are not actually grooved, but are noticeable only from their darker colour; the anterior pair are seen as short and almost point-like dots; the posterior pair are but little longer than the middle one which is sligtly curved. Thanks to the good state of preservation of the specimen, there can be seen on the glabella an ornamentation of close, fine lines running parallel with the posterior part and sides of the glabella, but which, towards the hinder part of the glabella, assume a more longtudinal direction, so that they there form longitudinal ovals or ellipses, enclosing each other.

The fixed cheek is confined to a narrow margin, surrounding the glabella. The character and proportions of the tongue-shaped prolongation agree exactly with the specimens figured by LINNARSSON. The neck ring, too, is provided with the fine ornamentation which, in this case, goes from side to side, and it also has a little tubercle in the middle. Signs of a tooth-like outline are visible on the posterior margin.

The hypostoma, shown in Fig. 12, certainly belongs to this specimen. It presents some differences from the hypostoma in *R. radians* BARR., but some of these seem to be the result of its not being entire. In BARRANDE's species, the hypostoma is bordered by a narrow list, which, inwards, is limited towards the central part by a narrow furrow (v. BARRANDES Pl. 43, Fig. 37 and 38). In the present specimen, this list does not seem to be present on the upper part of the upper lip, but, in return, it is seen on the sides, where it is broader and more prominent. The fine-line ornamentation exists here, too, and runs parallel to the sides, forming arcs which are closed downwards and the extremities of which begin from the upper margin.

The thoracic segment (Fig. 14), which consists of the rachis and almost the whole of the left pleura, is in perfect agreement with LINNARSSON's description, except in the fact that the anterior margin of the pleura has, in the middle, a bulging forwards and does not slope »evenly forwards-outwards». At the back edge of the rachis, there are, thus, (visible on the right side) nodules or teeth, and the surface is striated by the regular, fine transversal lines.

Judging by the description, *Remopleurides latus* OLIN is a special variety or species which is closely related to *R. dorsospinifer* PORTL. (OLIN, E.: Om de Chasmops-kalken och Trinuncleusskiffern motsvarande bildningarne i Skåne). The *R. sp.* however, from the Chasmops limestone, mentioned by WIMAN (Studien über das Nordbaltische Silurgebiet, II. — Bull. of the Geol. Inst. of Upsala, Vol. VIII, P. 108), and the species described under *R. latus* OLIN, and figured

in Pl. VIII, Fig. 25 and 27, from »the Baltic limestone», can, it seems to me, very well be *R. dorsospinifer* PORTL.

Be this as it may, however. As far as our present knowledge extends, the species *R dorsospinifer* PORTL. and nearly even the genus *Remopleurides* as such, occurs in Sweden earliest in the Chasmops limestone, and is a characteristic fossil of the Trinucleus shale too. LINNARSSON, for instance, has found the species now in question (v. op. cit.) in the Trinucleus shale at Fårdalaberget at Kongslena. In the red Trinucleus shale, it has been found by TÖRNQUIST at Vikarbyn in Dalecarlia (TÖRNQUIST, SV. LEONH.: Undersökningar öfver Siljansområdets Trilobitfauna, — S. G. U. Ser. C, No. 66, P. 38), and J. JÖNSSON mentions it from the same bed at Rödbergsudden, on the southern side of the bay south of Motala, Sweden (Beskrivning till kartbladet Motala. — S. G. U. Ser. Aa. No. 102, P. 20). OLIN's nearly related species *R. latus* OLIN, is from the Chasmops limestone in Scania. The other determined Swedish species, too, *R. radians* BARR., with the varieties *angustata* TÖRNQ., *R. sexlineatus* ANG. and *R. emarginatus* TÖRNQ., have been found only in beds younger than the Orthoceras limestone, from which facts may be deduced that the species of the genus *Remopleurides*, which have only *exceptionally* been met with in the youngest beds [1] of the Orthoceras limestone, are, as a rule, bound to the horizons succeeding to Orthoceras limestone and are characteristics or index fossils of these (of the Chasmops limestone and the Trinucleus shale).

Finally, I wish to mention in a few words the fossils obtained from the stonecore immediately above the one last dealt with, i. e., from »core-portion No. 139», or from a depth of $229{,}79$—$233{,}64$ m below the mouth of the drill-hole. The rock is a gray, sometimes yellow-flamy limestone, with here and there small yellow dots and grains, and with thin, and, as a rule, grayish black films of shale lying around harder lense-shaped pieces of limestone.

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[1] In the island of Öland, for instance, a *Remopleurides* species has been found, both in the *Centaurus-* and the *Ancistroceras* Limestone (Beskrivning till blad 5. S. G. U. Ser. A 1 a, P. 109).

Ptychopyge sp.

Pl. II, Fig. 15.

Part of a cheek of a trilobite, derived from part 1, or the lowest bit of »core-portion 139», appears to belong to this genus.

Illaenus sp.

Pl. II, Fig. 16.

The right anterior portion of a badly preserved *Illaenus*-pygidium has been found in the overlying part 2 of the same »core-portion 139».

Thorn of a trilobite?

Pl. II, Fig. 17 a and b.

As will be seen from the figures, it is a large and characteristic fragment of a »thorn» that has been found in part 3 of »core-portion 139»; still, it cannot be referred to any known species. It is figured in natural size and lay horisontally, along the diameter of the drill-core. The fragment found has therefore a length corresponding to this diameter or 21 mm.

The »thorn» is rounded, slightly compressed at the sides, and, at its thickest part, measuring from the upper surface to the lower, a diameter of 5 mm; at the other end it is 3 mm thick. At the thick end, there issues symmetrically on either side a smaller »thorn» about 5 mm long projecting obliquely outwards. The whole piece is provided on the surface with sculpture of small round even-grained tubercles. Seen from the side, it curves slightly towards the narrow end.

From the upper parts of the same »core-portion 139» and in the next higher part of the core, there have been found several trilobite fragments such as, e. g., of the cranidium, thorax and pygidium of an *Asaphus*, further of some small ostracodes, part of an *Orthoceras* and brachiopod fragments belonging to the genera *Orthis* and *Leptaena*.

With what has been said above, I have concluded this preliminary account of the result of the investigations of the best preserved fossils, obtained from the lowest 150 metres of the cores from the deep boring at Visby. But a few words remain to be said of the information these fossils give us on the geological horizons.

It may briefly be summarized as follows: Deepest down, superimposed on the gneiss, there rests a stratum, 104,4 m thick, of *Lower Cambrian Sandstone*, in which at a depth of 333 m, or 50 m above the subjacent layer of the sandstone, there was encountered *Mobergella Holsti* (MGB.). The other fossils found here are indeterminable.

Then follows a stratum, 36,6 m thick, of shale, belonging to the *Ölandicus-* and *Tessini-*zones of the *Paradoxides shale*. Here have been found the following fossils, characteristic of these beds: *Acrothele* (*Redlichella*) *granulata* (LNRS) at a depth of about 260 m, or approximately 123 m. above the underlying gneiss; *Acrotreta* LNRS. at a depth of 258 m; *Paradoxides Sjögreni* LNRS., 245 m below the mouth of the bore-hole, and *Ellipsocephalus polytomus* LNRS. about 242,6 m below the mouth. Other fossils found here are: *Obolus* (*Westonia*) n. sp.? (at a depth of about 272 m): unknown fossil (about 269 m below the mouth of the bore-hole); *Acrotreta uplandica* WIM. (at about 250 and 267 m depth); *Acrotreta sp.* (at about 258 m depth); *Paradoxides sp.* (at about 260 m depth): *Solenopleura?* sp., *Anomocare balticum* n. sp. and *Strenuella subgotlandica* n. sp. and free cheeks of *trilobites* (the last-named at a depth of about 242 to 244 m).

This is followed by a *3 metres thick deposit of Glauconitiferous Limestone*, in which was only found *Orthoceras*, *Bellerophon*, small ostracodes and fragments of brachiopods, among which was *Eoorthis baltica* n. sp. No index fossils could be found.

It is remarkable in the overlying, gray limestone, 5 metres thick and at a depth of about 236—237 m, to encounter *Remopleurides dorsospinifer* PORTL., or a index fossil for beds younger than or belonging to the upper part of the Orthoceras limestone. In addition to this fossil, there have been met in the core, *Cheirurus* sp. and fragments of other trilobites, together with small ostracodes.

There exists here, therefore, a great hiatus of the strata-series extending from the zone with *Paradoxides Forchhammeri* ANG. almost to the *Chasmops Limestone*. All the deposits that in other districts of Sweden lie between these two horizons are represented here by a bed, 3 metres thick, of glauconitiferous- (and phosphoritic-) limestone (possible to confer with Ceratopyge-limestone), in which encountered no index fossil, and the level of which, therefore, I have not been able to determine.

The upper beds of the middle Cambrian, *the whole of the Upper Cambrian* (*the Olenide shales*), and *the lowermost horizons of the Lower Silurian* (such as the *Dictyograptus-shale*, *the Ceratopyge Limestone* (?), *the Lower Graptolite shale*, and the lower parts of the *Orthoceras Limestone*) *are wanting*, and in their place there is found

only a glauconitic limestone-layer, 3 metres thick. Possibly this is to be compared with the Ceratopyge limestone, which in that case would be represented here.

The succession of strata for the lowest 150 metres of the bore-hole at Visby are, consequently, as follows:

	Thickness
The Intermediate Ordovicium: Chasmops limestone . .	5—6 m + (?)
Hiatus?	
Glauconitiferous limestone	3 m
Hiatus in the strata series.	
Lower part of the Middle Cambrium: Zones with Paradoxides Tessini and P. Œlandicus. — Shales	36,6 m
Lower Cambrium: Lower Cambrian sandstone	104,4 m
Archaean: Gneiss	20 m +

Explanation of Plate I.

Fossils from the lowest 150 metres of the diamond boring at the Visby Cement Factory, Gothland. — The figures in parentheses give, in round numbers, the depth in metres below the mouth of the bore-hole, at which the fossils were encountered.

Fig. 1. *Mobergella Holsti* (MBG.). Inner side of a shell with muscle impressions. — $^{5}/_{1}$. (333 m).

» 2. *Mobergella Holsti* (MBG.). — Fragment of upper side of a shell layer, — $^{6}/_{1}$. (333 m).

» 3. *Mobergella Holsti* (MBG.). — Part of the upper side of a shell: *a*. Seen from above. *b*. In section. — $^{6}/_{1}$. (333 m).

» 4. *Undeterminable Specimen.* — $^{5}/_{1}$. (333 m).

» 5. *Fragment of undeterminable non-articulated Brachiopod.* — $^{4}/_{1}$. (330,5 m).

» 6. *Obolus* (*Westonia*) n. sp.? Part of upper side of ventral shell. — $^{5}/_{1}$. (272 m).

» 7. *Unknown fossil.* — *a*. Natural size. *b*. — $^{4}/_{1}$. *c*. Part of the same fossil, showing how the oblique furrows of the limb run differently on different sides. Abt. $^{4}/_{1}$. (269 m).

» 8. *Acrotreta uplandica* WIMAN. — *a*. Outer side of a ventral shell. *b*. The same, seen from the side. — $^{7}/_{1}$. (267 m).

» 9. *Acrotreta uplandica* WIMAN. — *a*. Outer side of a ventral shell. *b*. The same, seen from the side. — $^{8}/_{1}$. (250 m).

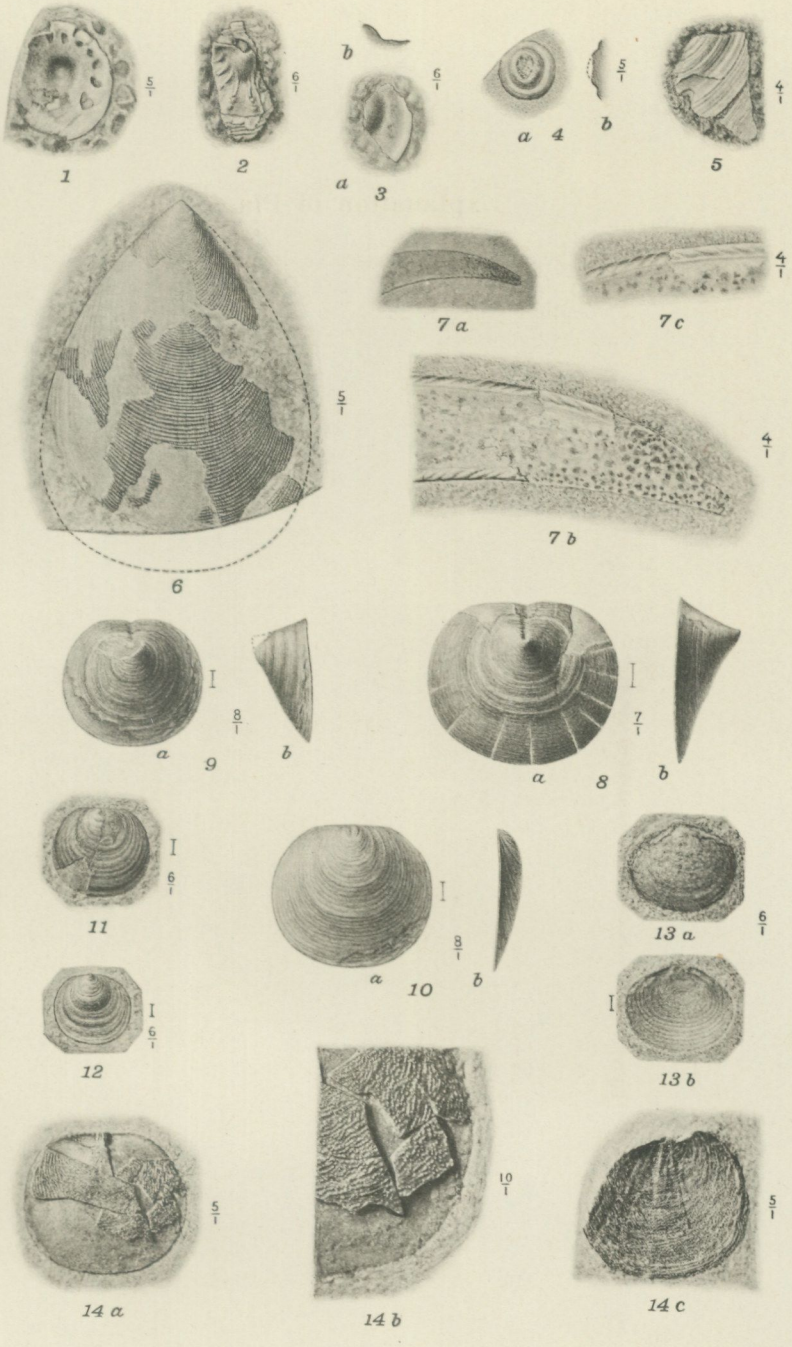
» 10. *Acrotreta uplandica* WIMAN. — *a*. Outer side of a dorsal shell. *b*. The same, seen from the side. — $^{8}/_{1}$. (250 m).

» 11. *Acrotreta* sp. — Dorsal shell. — $^{6}/_{1}$. (260 m).

» 12. *Acrotreta* sp. — Dorsal shell. — $^{6}/_{1}$. (260 m).

» 13. *Acrotreta*. — *a*. Mould of shell. The apex partially destroyed. *b*. The interior of the same shell, with shell substance. — $^{6}/_{1}$. (258).

» 14. *Acrothele granulata* LNRS. — *a*, A partly defect dorsal shell $^{5}/_{1}$. — *b*. The sculpture of the shell of the same specimen $^{10}/_{1}$. — *c*. Impression of fig. 14 a. $^{5}/_{1}$.



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Explanation of Plate 2.

Fossils from the lowest 150 metres of the core from the deep boring at the Visby Cement Factory, Gothland. The figures in parantheses give, in round numbers, the depth in metres below the mouth of the bore-hole, at which the fossils were encountered.

Fig. 1. *Paradoxides* sp. — Fragment of free cheek with genal spine. — $^{1}/_{1}$. (260 m).

» 2. *Paradoxides Sjögreni* Lnrs. — Compressed impression of the greater part of the cranidium. (245 m).

» 3. *Solenopleura?* sp. — Impression of the cranidium, with part of shell still attached. — $^{3}/_{1}$. (243 m).

» 4. *Anomocare balticum* n. sp. Cranidium. — $^{3}/_{1}$. (243 m).

» 5. *Ellipsocephalus polytomus* Lnrs. — Right posterior part of a cranidium. — $^{1}/_{1}$. (242,8 m).

» 6. *Strenuella subgotlandica* n. sp. — *a*. Cranidium. *b*. Transverse section of this, across the palpebral lobes. *c*. Longitudinal section of the cranidium. — $^{3}/_{1}$. (242,5 m).

» 7. *Ellipsocephalus polytomus* Lnrs. — Right posterior part of a cranidium. — $^{1}/_{1}$. (242,7 m).

» 8. Free cheek of trilobite. Sp. 1. — Right cheek from above. — $^{4}/_{1}$. (242,3 m).

» 9. Free cheek of trilobite. Sp. 2. — Right cheek from below. — $^{4}/_{1}$. (242,3). Both cheeks are attached to the same stratum surface.

» 10. *Eoorthis baltica* n. sp. — $^{4}/_{1}$. (241 m).

» 11. *Cheirurus* sp. Rachis and right pleura-part of a thoracic segment. — $^{2}/_{1}$.

» 12. *Remopleurides dorsospinifer* Portl. — Part of a hypostoma. — $^{5}/_{1}$. (238 m).

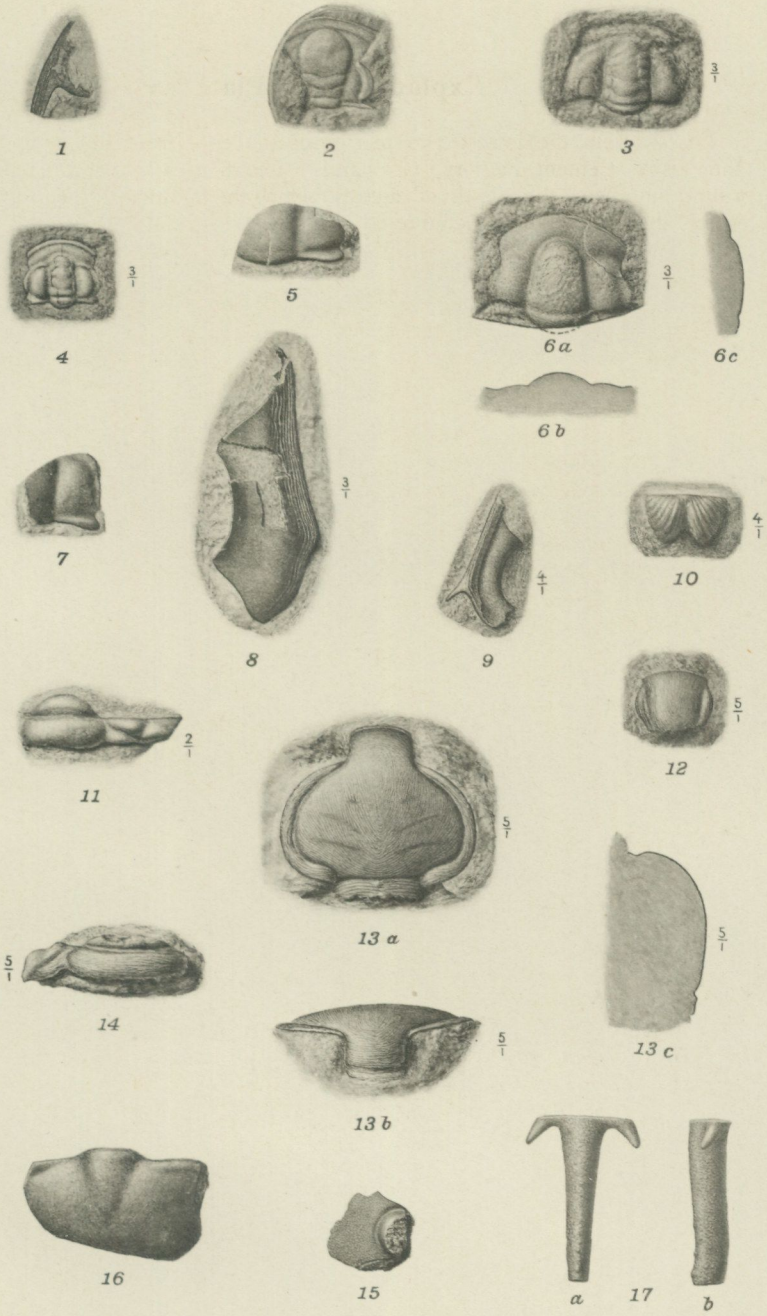
» 13. *Remopleurides dorsospinifer* Portl. — *a*. The cranidium, seen from above. *b*. The same, seen from the front. *c*. Longitudinal section of the centre of glabella. — $^{5}/_{1}$. (238 m).

» 14. *Remopleurides dorsospinifer* Portl. — Left side of a thorax segment, with rachis and left pleura. — $^{5}/_{1}$. (238 m).

» 15. *Ptychopyge?* sp. — Part of a free cheek. — $^{1}/_{1}$. (231—232 m).

» 16. *Illaenus* sp. — Anterior part of pygidium. — $^{1}/_{1}$. (231—232 m).

» 17. *Thorn of trilobite*. — *a*. Seen from above. *b*. Seen from the side. — $^{1}/_{1}$. (231—232 m).



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