SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C. Avhandlingar och uppsatser. **N:o 394.**

ÅRSBOK 30 (1936) N:o 1.

PARADOXIDES ŒLANDICUS BEDS OF ÖLAND

WITH THE ACCOUNT OF A DIAMOND BORING THROUGH THE CAMBRIAN AT MOSSBERGA

BY

A. H. WESTERGÅRD

With Twelve Plates

Pris 3: — kr.

STOCKHOLM 1936
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I. A Diamond Boring through the Cambrian at Mossberga.

As a part of the work carried out by the Electrical Prospecting Co. (A.-B. Elektrisk Malmletning) in order to search for gas in the Lower Cambrian of Öland, a deep boring was made in the autumn of 1933 into a little flat dome at Mossberga, about 12 km S of Borgholm. The Company had the courtesy to present the core to the Geological Survey, and thus the present writer had the opportunity of subjecting it to a closer investigation, the results of which are given below.

The boring was carried out about 700 m ESE of Mossberga into the little dome, the top of which had been destroyed owing to denudation. It reaches 106.2 m beneath the surface which is situated 39 m above sea level. In its uppermost part, to a depth of 8 m, the core has a diameter of 130 mm, from 8 to 70 m the diameter is 85 mm and, beneath the latter level, 32 mm.

The sequence is as follows:

	Thickness	Level
Soils: peat, lacustrine sediments, and moraine of shale disintegrated in the place	6 m	0—6 m
More or less arenaceous shales forming the lowest part of the Middle Cambrian, the *Paradoxides œlandicus* beds	40 »	6— 46.05 »
Sandstone, with conglomerates, Lower Cambrian	1.7 »	46.05— 47.8 »
Quartzite, Archaean	58.4 »	47.8 —106.2 »

Quartzite. From the bottom of the boring up to the 52 m level, i. e., about 4 m beneath the top of the quartzite, the rock is, broadly speaking, uniform. It is a true quartzite without any traces of a clastic texture. The quartz grains are sharply angular, interlocking, and show undulatory extinction. As a rule, other minerals, especially mica and feldspar, occur sparsely, and, rarely, very thin layers with a less quartzitic appearance are to be found, in which the latter minerals can occupy up to about the half of the rock. Other accessory minerals are carbonates, magnetite, chlorite, serpentine, zircon, apatite, etc. As a rule, the rock is fine-grained, sometimes even almost dense, but above the 72 m level there also occur fairly thick layers in which the quartzite is coarser in grain and somewhat porous. The colour is usually dark-grey or almost black, but in the lower portion of the core grey, red, and dark varieties alternate. The dark colour may be partly due to intermingled grains of magnetite and partly to a small content of carbonic matter. An analysis of a sample of a black and coarse variety shows, after the small content of CO^2, 1.25 %, has been removed, 0.26 % C (Dr. BYGDÉN). On different levels the quartzite is distinctly

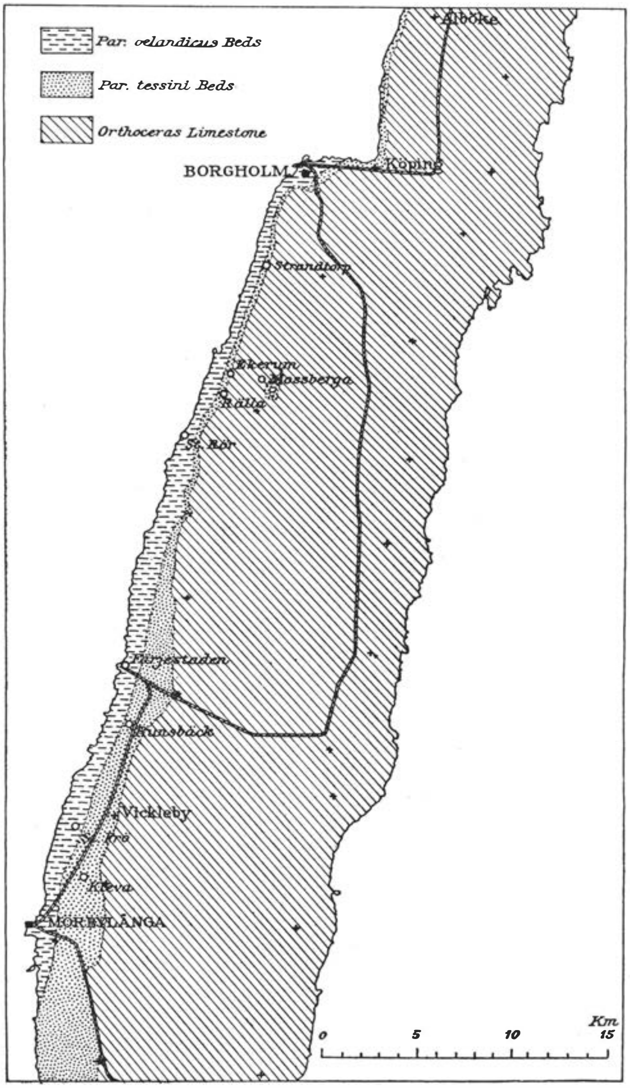

Fig. 1. Outcrop of the Œlandicus beds on Öland.

stratified, with the bedding plane dipping usually 20—25°, sometimes more and sometimes less. On some levels the quartzite is penetrated by numerous fissures, the surfaces of the pieces having a very thin coating of a black carbonaceous matter.

On the 52 m level the quartzite begins to change. It becomes lighter, gradually loses, in an upward direction, its appearance of a typical quartzite until near the top of the formation the rock recalls a hard sandstone white-spotted by kaolin. Slides prove, however, that it is a true quartzite of the same kind as the fresh one beneath the 52 m level and that the difference is only due to thorough weathering. The limit between the weathering zone and the covering conglomerate is, in reality, very sharp.

The petrographical character and the weathering zone at the surface of the formation tell us that the quartzite is much older than the covering Lower Cambrian deposits, and that it had been exposed to the weathering agencies for a very long time before the Lower Cambrian transgression took place.

When searching for probable equivalent deposits in the neighbourhood we can at once neglect the suggestion that the quartzite under Mossberga might be contemporaneous with the more or less quartzitic beds, in the lower parts of the Kalmarsund sandstone, which crop out in some places on islets in, and on the western shore of, the strait of Kalmarsund. As a rule, these rocks have the original clastic texture very well preserved; they should be named quartzitic sandstones, differing markedly from the true quartzite under Mossberga. Moreover, there exist facts which, in the present writer's opinion, prove that the Kalmarsund sandstone constitutes one unitary formation, and that, consequently, the quartzitic beds in question should also be included in the Lower Cambrian (Westergård, 1931, pp. 16—21).

However, a much older quartzite occurs in several places in the Kalmarsund area — e. g., on the peninsula of Skägganäs, N of Kalmar, and on the islet of Norra Skallarön, NE of that town — which agrees so closely with the Mossberga quartzite, megascopically as well as microscopically, that we may be justified in regarding all these occurrences as remnants of one formation. According to current opinion, the quartzites on Skägganäs and N. Skallarön form the southernmost outliers of the Västervik quartzite which is more widely distributed farther northward. Provided that this opinion is well-founded — and in all probability it is so — the Mossberga quartzite, too, is contemporaneous with the Västervik quartzite and, consequently, Lower Archaean in age.

Lower Cambrian Deposits and the Sub-Cambrian Land Surface. The quartzite surface under Mossberga formed part of the old land surface which was invaded by the sea in Lower Cambrian times. During this submergence there was first formed the Lower Cambrian basal conglomerate. In the core it has a thickness of about 15 cm (at a depth of 47.65—47.8 m) and consists of a very fine-grained grey and slightly brownish sandstone with embedded fairly angular pieces and worn pebbles of quartzite of the same kind as that in the subjacent formation.

The conglomerate is immediately covered by a 35 cm thick, grey sandstone (47.3—47.65 m) with very thin seams and small fragments of an arenaceous greenish-grey shale. This bed was deposited in very shallow and moderately agitated water, and probably the area was intermittingly laid dry. The bed next in order (46.65—47.3 m) is a fine-grained, fairly pure grey or brownish-grey

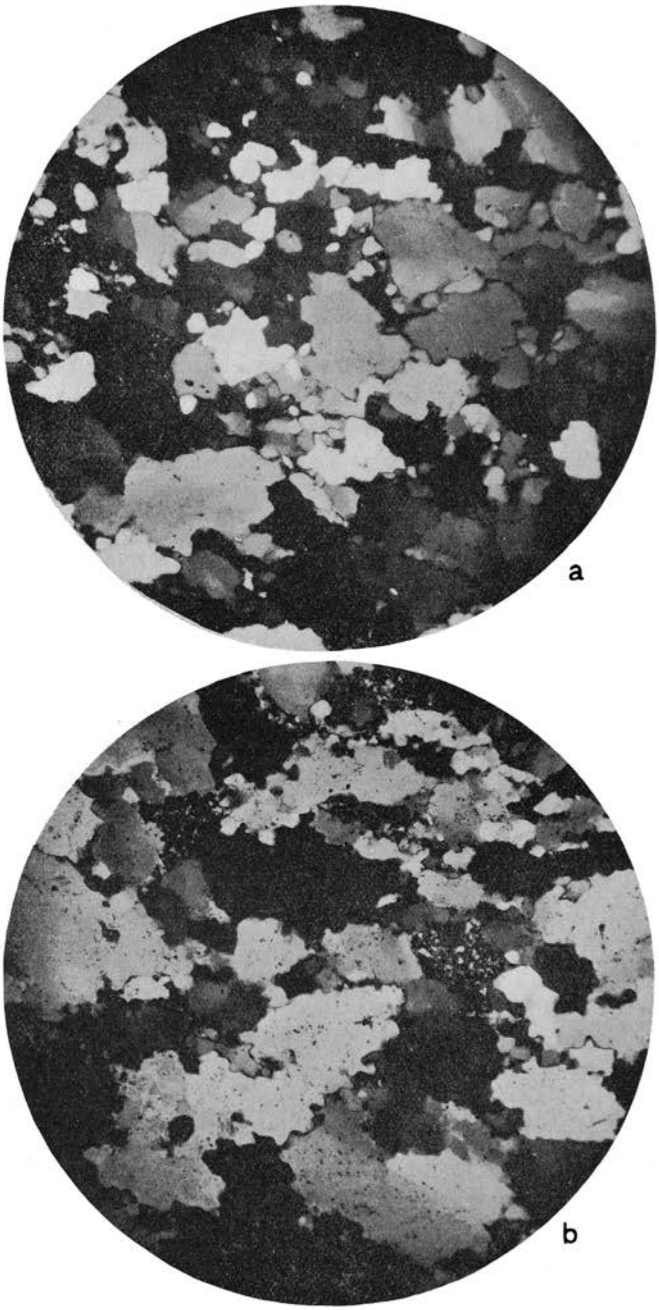

Fig. 2 a. Thoroughly weathered, light-grey quartzite, microphoto., nic. crossed, × 60. Mossberga, level 47.85 m.

Fig. 2 b. Unweathered, almost black quartzite, microphoto., nic. crossed, × 60. Mossberga, level 55.8 m.

In both slides the quartz grains are sharply angular, interlocking, and show undulatory extinction.

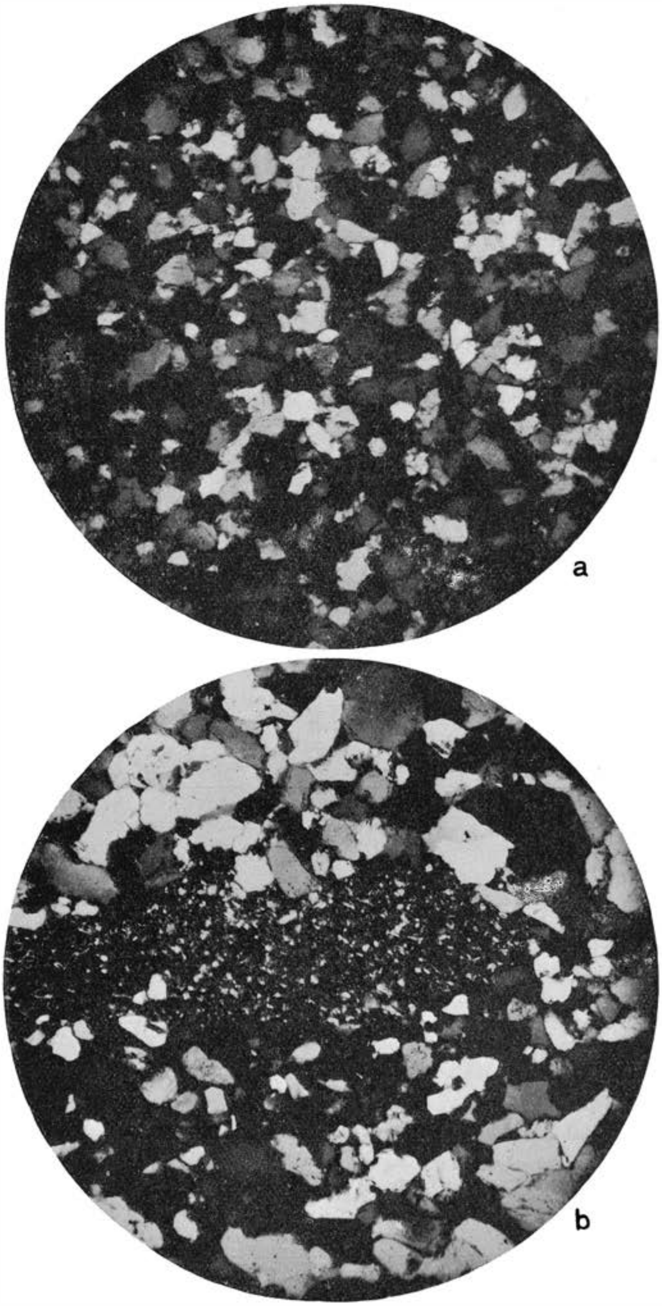

Fig. 3 a, b. Light-grey, fine-grained sandstone with the bulk of the quartz grains angular; in b, a fragment of greenish-grey clay shale; microphoto., nic. crossed, × 60. Mossberga; a, level 47.2 m; b, level 47.3 m.

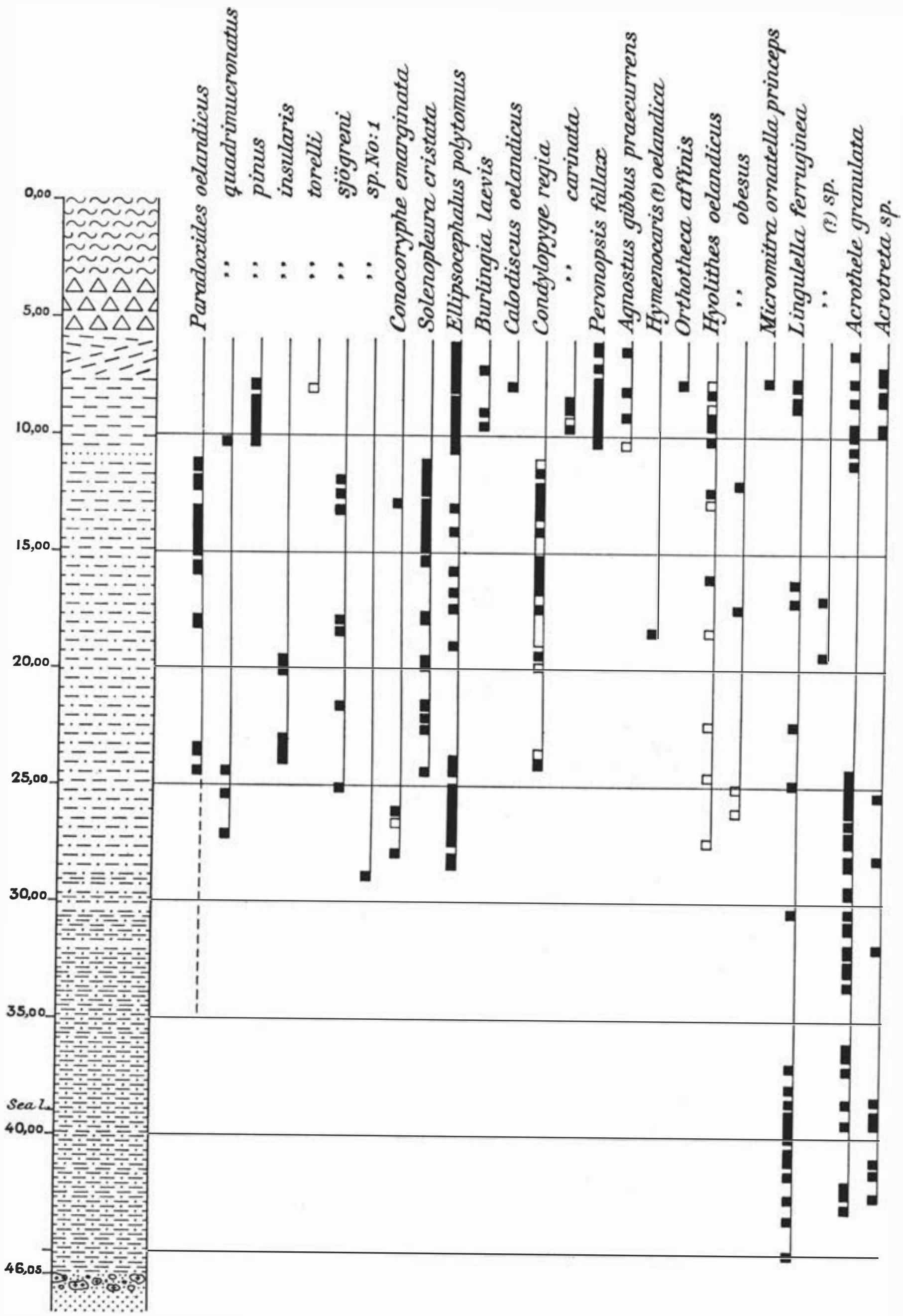

Fig. 4. Œlandicus beds of the Mossberga core, with the vertical distribution of the fossils found.

Black square = specimen identified without hesitation.
White » = » » with great probability.

sandstone, deposited in somewhat more agitated water. Upwards, it merges into a stratum, about 6 cm thick, of a pebbled sandstone with scattered pebbles of an extremely fine-grained, argillaceous, almost white sandstone evidently derived from a layer that was destroyed immediately after it was formed. Then follows a conglomerate which is 60 cm thick (46.05—46.65 m) and consists of two distinct subdivisions. In the lower portion, 50 cm thick, the matrix is a very fine-grained, somewhat pyritic, dark-grey sandstone larded with pebbles and more or less angular pieces of quartzite like that in the underlying quartzite formation. The upper portion, 10 cm thick, has a strongly glauconitic and,

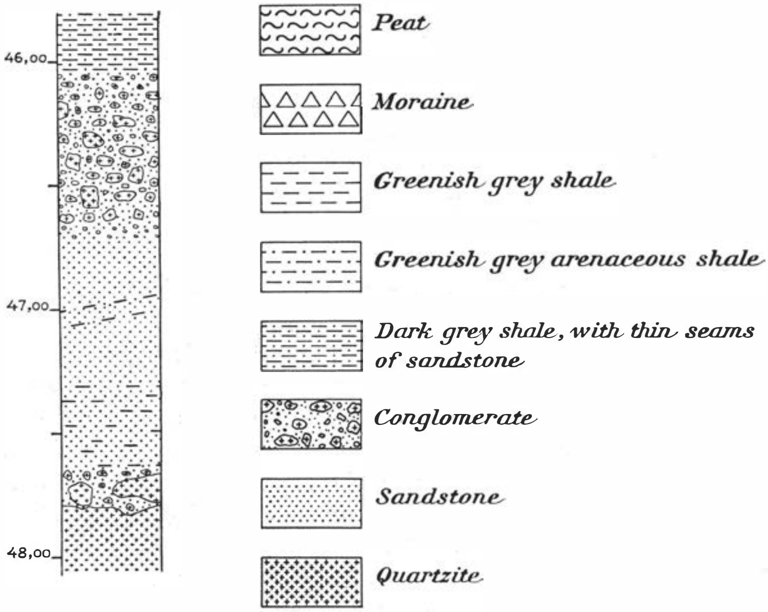

Fig. 5. Lower Cambrian deposits of the Mossberga core.

consequently, green-coloured matrix containing pebbles of quartzite and nodules of dark-brown dense phosphorite. In the matrix there occur small fragments of crushed non-identifiable brachiopod shells. — The conglomerate is immediately covered by the *Paradoxides œlandicus* shale.

The comparatively great thickness of the upper conglomerate, and the abundance of quartzite pieces, indicate that the quartzite formation may reach to a higher level somewhere in the vicinity of the boring, that it has there never been covered with Lower Cambrian sediments, and could thus supply material to the conglomerate.

The conglomerate records the changes of the sea level during the transition from the Lower to the Middle Cambrian epochs. At the end of Lower Cambrian times, an emergence took place which can be traced in other areas of Sweden and in the Southern Baltic (Bornholm) too, and which probably brought the greater parts of Scandinavia above sea level. In very early Middle Cambrian times even, the emergence was succeeded by a submergence which reached the Middle Baltic earlier than it did in the Southern Baltic, Scania, and Västergötland and which led to a new epoch of sedimentation. In the present writer's opinion, the bulk of the conglomerate was formed during the regression, and only the uppermost glauconitic and phosphoritic part during the transgression. The boundary between the Lower and Middle Cambrian should, consequently, be drawn within the conglomerate, at the base of the glauconitic portion, where a sharply marked lithological boundary is to be found. Be this as it may, the thickness of the Lower Cambrian is inconsiderable in the core, less than 2 m.

The very small thickness is the most remarkable feature of the Lower Cambrian in the sequence at Mossberga. Only from one more place, in the vicinity of Solliden, somewhat less than 10 km N of Mossberga, a deep boring has pierced the Lower Cambrian sandstone and proved it to be 78 m. A deep boring at Borgholm goes 59 m, and several borings at other places on Öland, 10 to 20 m, into the Lower Cambrian without reaching its sub-stratum. So great a difference in thickness of the Lower Cambrian in neighbouring places as that found at Mossberga and at Solliden is rather unique in Sweden. As a rule, the thickness is fairly constant within one and the same area, this evidently, being due to the remarkably even sub-Cambrian land surface. In the Kalmarsund area, however, this old surface seems to have been uneven to a greater extent than is usually the case. Thus, Dr. Hedström (1906) has pointed out that the small scattered occurrences of quartzite in the southern and middle parts of the Kalmarsund area formed small monad nocks on the sub-Cambrian surface when it was invaded by the Cambrian sea, and for some time formed islets in this sea. As a clear illustration of this he mentioned Runnö Rödskär, a small quartzite islet off Påskallavik where, even to-day, the quartzite arises steeply about 5 m above the Lower Cambrian basal bed which is exposed at the foot of the western rock wall. And the quartzite hill now revealed under Mossberga rises possibly almost 100 m above the granite surface in the neighbourhood — the surface of the quartzite at Mossberga being 9 m and the granite surface at Solliden 106 m below sea level.

How are we to explain this topography? If we imagine a fairly flat and barren land built up of granite, porphyry, and leptite, and with scattered plots of quartzite, i. e., a country of a character probably existing in the Kalmarsund area in late pre-Cambrian times, and if we further imagine that this land was for a long period exposed to denudation, especially aeolian, it seems as if the quartzite plots should, in course of time, form hills in the landscape. In the comparatively greater power of resistance to denudation possessed by the quartzite we have, it would seem, a conceivable reason at least for the topography in question. But other causes may certainly be taken into account too. Thus, it does not appear to be quite improbable that the quartzite occurrences on Skägganäs and N. Skallarön — possibly the one under Mossberga too since the longer axis of the dome, when prolonged, cuts the quartzite occurrence on N. Skallarön — may have formed small flat horsts, even in late pre-Cambrian times. On Skägganäs as well as on N. Skallarön, the quartzite is pierced by breccias consisting of angular pieces of quartzite cemented by white quartz, and with the fault surfaces forming slickensides. Probably, these breccias are very old and, as pointed out by Hedström, were formed before the Lower Cambrian submergence took place, for, if they were younger than the latter,

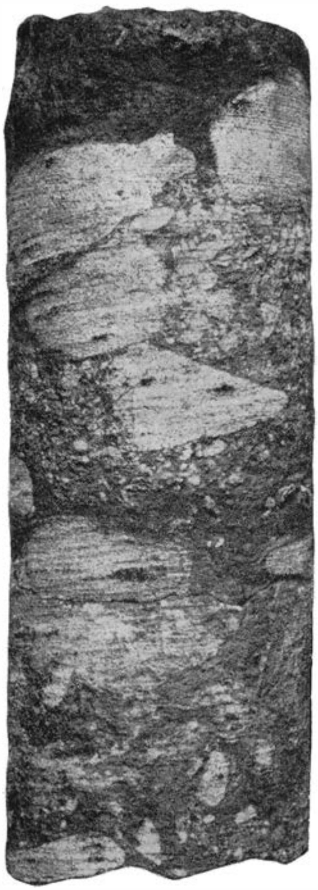

Fig. 6. Portion of the core of the conglomerate covering the Lower Cambrian sandstone. The fine-grained, somewhat pyritic, dark-grey sandstone-matrix is larded with pebbles and more or less angular pieces of light-grey quartzite. Level: 46.15—46.40 m. — Half nat. size.

one would expect to find in them, somewhere or other, pieces of Lower Cambrian sandstone too, but such have, so far, never been observed. However, the present writer cannot enter into further particulars of this question, as he does not know by autopsy the quartzite occurrences under consideration.

Paradoxides œlandicus Beds. The lower portion of the Œlandicus beds, from the conglomerate up to the 32 m level, consists of a dark-grey or almost black somewhat bituminous clay-shale, often with an abundance of extremely thin seams of grey sandstone. Between 32 and 29 m, alternate dark-grey shale and lighter greenish-grey fairly arenaceous shale. Above the latter level the greenish-grey arenaceous shale is the only rock present, and it continues up to 11.1 m, where it is covered by a 0.3 m thick stratum of greenish-grey argillaceous and calcareous sandstone. At 10.8 m and thence upwards there appears another greenish-grey shale which is less arenaceous and is softer than the lower one. The highest strata are somewhat displaced by the continental ice, and the covering moraine consists exclusively of fragments of the same kind of shale in a clayey matrix. It may be assumed that the eroded part of the Œlandicus shale originally had a thickness of at least 5 and, probably, about 10 m (see p. 21).

The Œlandicus beds of the core consist, accordingly, of three principle divisions of somewhat different lithological character indicating somewhat different milieu conditions of formation, and these different ecological conditions are fairly well reflected by the fauna found in the core.

Three-fourths of the total fauna of the unit are found in the core, which is a remarkably high figure when we consider that the core is only 85 mm thick, and that at least three of the species found are rare. More than 600 fragments safely specifically indentifiable are present and belong to the species given below. Their vertical distribution is seen from Fig. 4 in which exclusively safely identifiable fragments are recorded. Consequently, in order to avoid possible errors of identification only pygidia of the *Paradoxides* forms of the *œlandicus* group and only cranidia of *P. sjögreni* and *P. insularis* are recorded in the diagram mentioned.

Paradoxides œlandicus (22 pygidia)
» *quadrimucronatus* (4 pygidia)
» *pinus* (20 pygidia)
» *insularis* (12 cranidia)
» *torelli* (part of thorax)
» *sjögreni* (8 cranidia)
» sp. No. 1 (1 free cheek)
Bailiella emarginata (4 cranidia and part of a thorax with attached pygidium)
Solenopleura cristata (48 cranidia, 14 free cheeks, 2 fairly complete thoraces and a number of detached thoracic segments)
Ellipsocephalus polytomus (124 cranidia, 20 free cheeks, 1 complete thorax, an abundance of detached thoracic segments, and 9 pygidia)
Burlingia lævis (4 rather complete specimens and 2 fragments)
Calodiscus œlandicus (2 cephala)
Condylopyge regia (31 pygidia and 37 associated cephala)
» *carinata* (7 pygidia and 5 associated cephala)
Peronopsis fallax (3 complete specimens, 26 cephala and 33 pygidia)
Agnostus gibbus præcurrens (4 cephala and 6 pygidia)
Hymenocaris (?) *œlandica* (1 defective carapace)
Orthotheca affinis (1 specimen)
Hyolithes œlandicus (at least 8, probably 15, specimens)
» *obesus* (at least 3, probably 5, specimens)
Micromitra (*Iphidella*) *ornatella princeps* (1 small dorsal valve)
Lingulella ferruginea (43 valves)
» (?) sp. (2 defective valves)
Acrothele (*Redlichella*) *granulata* (37 dorsal and 41 ventral valves)
Acrotreta sp. (6 dorsal and 24 ventral valves)

The lower dark-grey and slightly bituminous shale is very poor in fossils. However, a few brachiopods appear even in its lowest part and persist through

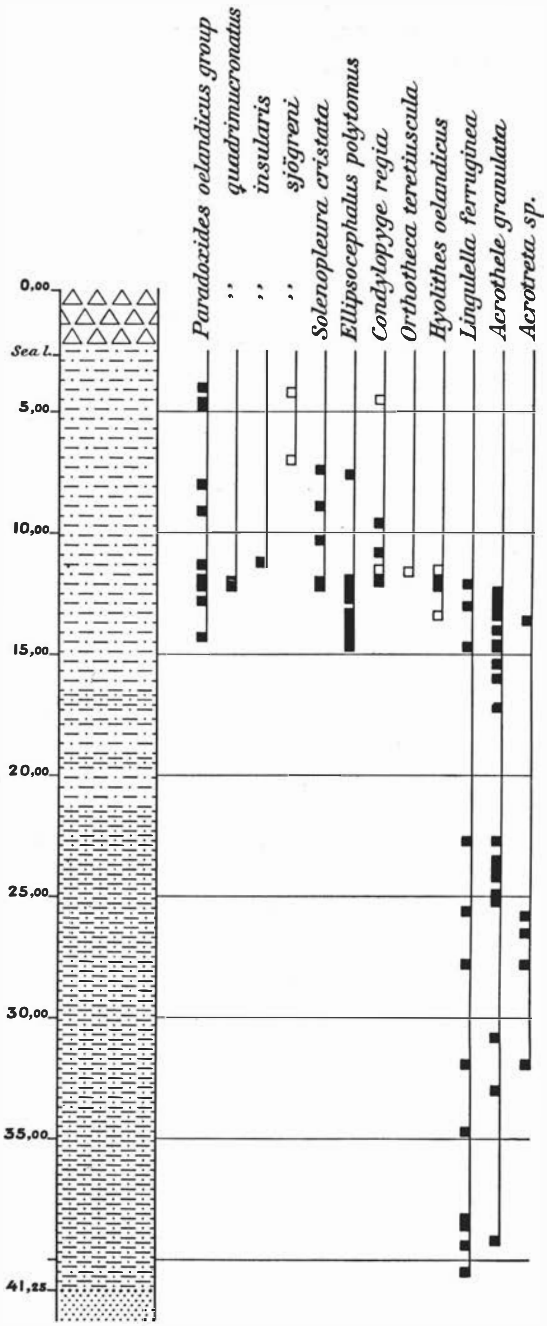

Fig. 7. Œlandicus beds of the Borgholm boring core, with the vertical distribution of the fossils found. Legend in Fig. 5.

the entire shale series. The oldest trilobite found — a free cheek probably of a species of the *Par. œlandicus* group — was met with on the 35 m level, and a few more non-determinable *Paradoxides* fragments were found somewhat higher.

The change in the ecological conditions on the 29 m level is clearly reflected by the fauna: a series of trilobites and *Hyolithidae* appear abruptly above this level. The lithological limit on the 10.8 m level too constitutes a sharply marked palaeontological limit.

Comparison of the Mossberga and Borgholm Profiles. A 100 m deep boring, made at Borgholm in 1900, pierced 38.7 m of the Œlandicus shale and 58.7 m of the Lower Cambrian sandstone (Westergård, 1929). For comparison with the sequence of the Mossberga core, the writer has re-examined the material of the Œlandicus shale of the former core and drawn the diagram in Fig. 7. The sequence between 11 and 46.05 m at Mossberga corresponds fairly well to the one between 2.5 and 41.25 m at Borgholm as regards the lithological character as well as the fauna, excepting that the lower dark shale is somewhat thicker in the latter place than in the former, which may be due to the surface of the Lower Cambrian, even at the time when the Œlandicus beds were deposited, having been somewhat higher at Mossberga than in the neighbourhood. On the other hand, strata equivalent to the soft shale above the 10.8 m level at Mossberga are absent in the core of Borgholm owing to denudation. In other places at Borgholm these strata are to be found however, e. g., at the hospital, where a 3.5 m deep well-sinking goes through a soft shale displaying the fauna of the *Par. pinus* zone known from Mossberga. The scantiness of the fauna of the Borgholm core, both with respect to the number of species and also to that of specimens is, to some extent, due to this core being narrower (48 mm) than the one from Mossberga, but principally depends on the absence of the upper, highly fossiliferous strata.

II. Paradoxides œlandicus Beds of Öland.

Introduction and History.

The solid rocks of Öland consist exclusively of Cambrian and Ordovician strata which, broadly speaking, dip very gently to the east but in some places form very flat anticlines lying, approximately, ENE-WSW. As mentioned above, there exists a small and flat oval dome at Mossberga the longer axis of which has, too, the direction mentioned. In agreement with this simple structure, the oldest strata crop out on the western, and the youngest strata on the eastern, shore of the island (cf. Fig. 1).

The oldest solid rock found on Öland forms the very top of the Lower Cambrian sandstone — the lower parts of which crop out in the coast region W of Kalmarsund — and rises above sea-level only within a small area on the shore at Mörbylånga. The unit next in age, the *Paradoxides œlandicus* beds, consisting of more or less arenaceous, usually greenish-grey, shales with lenses of argillaceous and arenaceous limestone of the same colour as the shale, occupies a very narrow strip along the shore from the neigbourhood of Mörbylånga to the neighbourhood of Borgholm. It is concealed by Quaternary deposits, and only small parts of it are accessible, and that but in some scattered places. The covering *Paradoxides tessini* beds, consisting of a grey, more or less calcareous, thin-bedded sandstone with seams of greenish grey clay shale, occupy another narrow strip, between the Œlandicus beds and the cliff of Västra Landborgen. The cliff itself is formed by the outcrops of the superjacent layers: the *Paradoxides forchhammeri* beds which are here represented by the very thin and sporadic Exporrecta conglomerate, the Olenidian (alum shale with stinkstone), the Ceratopyge shale and limestone, and the lowest part of the Orthoceras limestone, viz., the basal strata of the zone of *Megalaspis planilimbata*.

Before 1851 only two divisions of the sequence of the Kalmarsund area now referred to the Cambrian were distinguished: the sandstone — in which the thin-bedded and shaly sandstone (the Tessini beds) was also included— and the alum shale. In the year mentioned, Anton Sjögren separated the Tessini beds from the sandstone proper (Lower Cambrian). He had observed good sections of the former in some places on the western shore, e. g., at Albrunna, 23 km S of Mörbylånga, and at Äleklinta, 13 km NNE of Borgholm. In these beds he had found *Paradoxides tessini* BRONGN. and an *Ellipsocephalus* which he indentified as *E. hoffi* (SCHLOTH.) but which is distinct from this form and should be named *E. lejostracus* (ANG.). For palaeontological reasons, consequently, he correlated them with the oldest fossiliferous deposits of Bohemia.

In two papers of 1871 and 1872, Sjögren distinguished one more unit, »greyish clay shale carrying gypsum» (Œlandicus beds) which he had found at Borgholm and Stora Frö, in the parish of Vickleby. Being unable to discover by direct observations the stratigraphical position of this unit in relation to the Tessini beds, Sjögren erroneously regarded the former, for lithological reasons, as younger than the latter. From the Œlandicus beds he described the following species and roughly illustrated some of them:

Paradoxides œlandicus
» spp. indet. (four species of which at least one, probably all, belong to *P. sjögreni*)
Ellipsocephalus hoffi (in which Sjögren included both *E. polytomus* from the Œlandicus beds and *E. lejostracus* from the Tessini beds)
Ellipsocephalus sp. indet. (probably large specimens of *E. polytomus*)
Conocoryphe dalmani? (= *Bailiella emarginata*)
Agnostus regius
» sp. indet. which was stated to resemble *A. integer* and *A. gibbus*
Theca sp. indet. (*Hyolithes*)

After a visit to Öland in 1876, Linnarsson expressed grave doubts as to the correctness of Sjögren's conception of the relative position of the Tessini sandstone and the Œlandicus shale. At Äleklinta and Degerhamn (S. Möckleby) Linnarsson found that the Tessini sandstone is immediately overlain by the alum shale and, consequently, should be expected to cover the Œlandicus shale, but the conditions at Borgholm made him doubtful, and so he left the question undecided. In a subsequent paper, Linnarsson (1877) described and figured the whole of the fauna collected up to that date from the Œlandicus beds of Öland:

Paradoxides œlandicus
» *sjögreni*
» *aculeatus* (an immature form, probably of *P. pinus*)
» sp. indet. (= *P. quadrimucronatus*)
Ellipsocephalus polytomus
Conocoryphe emarginata
Solenopleura cristata
Agnostus fallax
» *gibbus* var. (= *A. gibbus praecurrens*)
» *regius*
Hyolithes teretiusculus
Acrothele granulata
Lingula sp. (listed only; = *Lingulella ferruginea?*)
Acrotreta socialis (listed only)

In 1881, Dames and Nathorst (Dames, 1881) definitively proved, by observations made at Borgholm, that the Œlandicus shale is overlain by the Tessini sandstone. The former unit Dames regarded as contemporaneous with, and as an eastern facies of, the zone of *Holmia* (»*Paradoxides*») *kjerulfi* which was hitherto known only from Western Scandinavia (Scania and Norway). This opinion was strongly opposed by Nathorst (1882), however, who based his statements partly on the markedly different faunas of the units, and partly on recent researches by Brögger (1882) in the Mjösen area of Norway where the latter scientist had found both the units developed, the Kjerulfi zone distinctly overlain by the Œlandicus zone.

In a monograph on the *Hyolithidae* of Sweden, Holm (1893) described the following species from the Œlandicus shale of Öland:

Hyolithes	*(Orthotheca)*	*corneolus*	*Hyolithes*	*œlandicus*
»	»	*teretiusculus*	»	*obesus*
»	»	*affinis*	»	*socialis*

In the explanations of the map sheets of Kalmar (Munthe, 1902) and Mönsterås with Högby (Munthe & Hedström, 1904) the distribution and lithological character of the Œlandicus shale are treated of, and in the explanation of the rock-map sheet No. 5 (Hedström & Wiman, 1906) a complete list of fossils from the Œlandicus shale of Southern Öland is also to be found. There are recorded the following three species not before mentioned from this unit, viz., *Microdiscus* sp. (*Calodiscus œlandicus*), *Conocoryphe tenuicincta* LINRS., and *Liostracus aculeatus* (ANG.). Judging from the vertical distribution of the two latter species in other areas, it can scarcely be doubted, however, that they should be excluded from the fauna of the Œlandicus shale. In all probability, they were collected from a stratum which, on account of its lithological character, was referred to the Œlandicus shale but which, in reality, belongs to the lower part of the Tessini beds.

In 1929, the present writer gave an account of a diamond-boring at Borgholm through the Œlandicus shale (38.75 m) and Lower Cambrian sandstone (58.75 m), and in the same paper published a complete list (without descriptions and figures) of the fauna of the former unit, embracing 28 species, 9 of which were still undescribed.

Distribution, Thickness, and Stratigraphy.

As stated above, in southern and northern Öland the Œlandicus beds lie beneath sea level. 4.5 km S of Mörbylånga the unit rises above sea level and again descends beneath it about 6 km NE of Borgholm. Between these places it occupies about one half of the narrow strip between the shore and the cliff of Västra Landborgen, and a very small isolated area of Œlandicus shale is found at Mossberga, where it forms the solid rock beneath the soils in the centre of the above-mentioned dome.

As a rule, the shale is concealed by the Quarternary deposits, and any very large natural sections are wholly wanting. Accordingly, our knowledge of the unit is mainly founded on the boring cores from Mossberga and Borgholm, and well-sinkings at Borgholm and other localities. Small portions of the shale are exposed, however, in fairly many places on the very shore, especially between Borgholm and Ekerum, as well as in brooklets and ditches, and at other localities it may be studied in abundantly occurring blocks and boulders derived from strata disintegrated in the place. Consequently, if one follows the shore from Stora Rör to Borgholm one obtains a comparatively complete section from the oldest to the youngest strata of the unit. At some distance to the north of Stora Rör, blocks and boulders of a dark or almost black shale are common, and sometimes the gravel consists almost exclusively of this shale which agrees with the lowest dark shale of the boring cores. Lenses, too, of a non-fossiliferous, dark and impure limestone, with cone-in-cone structure doubtlessly originating from the same horizon, are here met with. Farther to the north, the dark shale disappears from the boulders and the gravel and is replaced by a greenish grey arenaceous shale. This is also found as solid rock on the shore itself 2 km N of Ekerum, where it has yielded a very large *Paradoxides* (sp. No. 1) which also occurs in the lowest strata of the greenish grey shale at Mossberga. In several places between the latter locality and Borgholm, there crops out greenish grey arenaceous shale with lenses and layers of impure limestone or calcareous argillaceous sandstone containing the fauna of the analogous strata of the boring cores. Only within or immediately south of Borgholm is the uppermost soft shale with *Paradoxides pinus* met with.

The above-mentioned lithological tripartition of the Œlandicus shale seams to have general validity for Öland, save that the lowest dark and bituminous portion thins out to the south. Thus it appears to be lacking in the sequence at Mörbylånga. It is true that the basal strata of the unit have not been observed *in situ* at this locality but in the low shore-bank on the point immediately south of the harbour there occurs a moraine consisting exclusively of greenish grey and arenaceous, in part glauconitic, shale which is in all probability derived from the bottom layers of the unit in this place.

The b o u n d a r y between the Œlandicus shale and the subjacent Lower Cambrian has been observed only in the two boring cores and, in both, is lithologically well-defined. At Mossberga, the shale is underlain by a conglomerate, the upper portion of which, rich in glauconite and nodules of phosphorite, should probably be incorporated with the Œlandicus beds (p. 12). At Borgholm, the shale is underlain by a layer, about 15 cm thick, of a phosporitic and glauconitic argillaceous sandstone with coarse quartz grains, which downwards merges into the normal Lower Cambrian sandstone. At Mörbylånga, the boundary is not accessible, but from blocks and boulders we may infer with fairly great certainty that the greenish grey arenaceous shale is directly underlain by a dark, in part glauconitic, conglomeratic sandstone with pebbles of sandstone and nodules of phosporite, in which the Lower Cambrian terminates.

The upper boundary, too, of the unit is lithologically and faunistically sharply marked wherever it has been observed, viz., at Borgholm (in the brooklet at Rosenfors); on the shore 2 km E of Borgholm; in a well-sinking at Runsbäck, 12 km NNE of Mörbylånga, and on the shore 4.5 km S of Mörbylånga. In all these places the greenish gray soft shale is immediately covered by the *Acrothele granulata* conglomerate, a thin, rarely more than 10—15 cm thick, calcareous layer larded with pebbles of greenish grey impure limestone and shale similar to the subjacent rocks and containing *Paradoxides* of *œlandicus* type, *Ellipsocephalus polytomus*, and *Acrothele granulata.* In the matrix, which, to a large extent, consists of shell fragments of trilobites and brachiopods, occur, *inter alia, Paradoxides tessini* and *Liostracus aculeatus,* proving the conglomerate to form the basal stratum of the Tessini beds.

According to a personal communication by Dr. O. Meier the total thickness of the unit is stated to be 57 m in a boring 2.5 km S of Borgholm. Probably it has about the same thickness at Borgholm, and, accordingly, the portion lacking in the core may be estimated at about 18 m, the greater part of which may belong to the soft shale with *Par. pinus.* Where the unit attains its greatest thickness is undecided, but we may assume it to be in the neighbourhood of Borgholm or, possibly, somewhat farther to the east or the north. From this place the unit decreases southward as well as northward. As mentioned above, at Mossberga the unit can hardly be more than 50 m thick; at Mörbylånga it is probably less than half as thick as at the former locality, and farther to the south it thins out completely. Thus, in the Southern Baltic (Bornholm) it is wholly absent, and the Scanian strata which, according to some geologists, should be correlated with the Œlandicus stage — an opinion which is not corroborated by any actual evidence — are at all events very thin, and probably the unit is not developed in that area. In Östergötland, the Œlandicus stage may be about 10 m thick (certainly less than 15 m); under Gotland (Visby) it is proved to be 36.6 m, and in the Northern Baltic area it seems to be altogether lacking.

Fossils occur abundantly in parts of the Œlandicus beds, and in the limestone lenses especially they are often found in a perfect state of preservation. Broadly speaking, the uppermost soft shale is, relatively, most fossiliferous even though fossils are common too in scattered strata of the greenish grey arenaceous shale. On the other hand, the lowest dark shale, which is seldom accessible and, accordingly, imperfectly known, seems to be far poorer, and has as yet yielded hardly anything excepting brachiopods.

The vertical distribution of the fossils of the Mossberga core (see the diagram on p. 10) indicates that the Œlandicus beds of that section may be divided into two zones separated by a rather sharply marked limit at the 10.8 m level. Since it must be considered as a mere chance whether fossils are found or not in a narrow boring-core, one might suggest that this limit is possibly unreal and only apparent. However, if we compare the lists of fossils from all localities of Œlandicus shale, relatively to each other and to the list from the core, we shall find 1:o, that all species from each locality appear either above or beneath the 10.8 m level in the diagram, Fig. 4; 2:o, that from none of the localities (except an old, deep well-sinking at Borgholm the fossils of which lack notes as to the level) does the fauna embrace forms which, in the core, are found exclusively in the upper division associated with forms undoubtedly restricted to the division beneath 10.8 m. This fact proves that the limit shown in the diagram on the level mentioned forms a true palaeontological limit which not only possesses local validity, but also divides the Œlandicus beds of the whole of Öland into two zones: an upper one — the zone of *Par. pinus* — and a lower, the zone of *Par. insularis.* — For the present at least there are no reasons for separating the lowest almost barren and as yet imperfectly known shale bed as a third palaeontological zone.

To the question, whether this palaeontological division is applicable to the unit in other areas too, we can at present only answer that data, hitherto known especially from Jämtland, seem to indicate that future investigations will probably show it to be of general validity for Scandinavia wherever the Œlandicus beds are approximately completely developed.

Acknowledgements. From a well-sinking in 1889, at the Borgholm hospital, which pierced the uppermost layers of the Œlandicus beds to a depth of 3.5 m the late Professor G. Holm, at that time palaeontologist of the Geological Survey, collected an abundant material on which the following description of the fauna to a large extent is based. Holm himself intended to describe this fauna, and he had made illustrations of the new forms found, but no text to them was discovered in the papers he left. These illustrations, in the possession of the Palaeozoological Department of the State Museum, as well as all the collections from the Œlandicus beds kept in that Museum were kindly put at the writer's disposal by Professor E. Stensiö, for which courtesy the writer desires here to express his gratitude. Several of Holm's illustrations are reproduced in this paper.

The writer also wishes to tender his thanks to Dr. N. H. Magnusson for kind assistance in examining the slides of the rocks.

Fauna.

Brachiopoda.

Family **Paterinidae** SCHUCHERT.

Genus **Micromitra** MEEK, 1873.

Subgenus *Iphidella* WALCOTT, 1905.

Micromitra (*Iphidella*) *ornatella princeps* n. var. Pl. VIII, Figs. 8—10.

R e m a r k s. In the ventral as well as the dorsal valve this form agrees with *M.* (*I.*) *ornatella* (LINNARSSON, 1876); only in the surface ornamentation does there seem to exist any difference. The ornamentation is of the same type in both, but shows markedly greater irregularity, the pits between the ridges varying more in size and form in the variety than in the species. As a rule, larger shells of the variety show, near the margin, undulating or crenulated concentric lines which do not, however, form a complete network, and, accordingly, the marginal portion displays an ornamentation quite different from that farther back on the shell (cf. Fig. 10 a).

This form is also nearly allied to *M.* (*I.*) *pannula* (WHITE) which has a wide geographical distribution in the Lower and Middle Cambrian of North America. In the form of the false area and the pseudodeltidium of the ventral valve, as well as in the surface ornamentation, there appear to exist small differences, however.

Dimensions. One large dorsal valve is 4.8 mm long and 5.8 mm broad, a large ventral valve 5.5 mm long and nearly 7 mm broad. Thus the average size of the variety is somewhat greater than that of the species.

Horizon and locality. Zones of *Par. insularis* and *Par. pinus.* Öland: SW of Alböke; Borgholm; Mossberga; Mörbylånga (boulders). Östergötland: Berg (boulders). Närke: Hjortsberga, parish of Kumla; Björsholm, parish of St. Mellösa (boulders). Jämtland: Several localities in the Storsjön area. — Very rare in Öland.

M. (*I.*) *ornatella* occurs in the Forchhammeri beds of Scandinavia. A few specimens have also been found in the conglomerate of *Acrothele granulata,* E of Borgholm.

Family **Obolidae** (KING) WALCOTT.

Genus **Lingulella** SALTER, 1866.

Lingulella ferruginea SALTER, 1867.

Lingulella ferruginea, Salter, 1867, p. 340, Fig. 1. (Described as a new species.)
Lingula or *Lingulella* sp., Linnarsson, 1876 a, pp. 15—16, Pl. 3, Figs. 24—28. (Described and discussed; Figs. of four valves from the Forchhammeri beds of Sweden and Bornholm, Denmark.)
Lingulella sp. indet., Linnarsson, 1879, p. 25, Pl. 3, Figs. 38, 39. (Description and Figs. of two valves from the zone of *Ctenocephalus exsulans* at Kiviks-Esperöd, Scania.)
Lingulella ferruginea, Walcott, 1912 b, p. 496, Pl. 29, Figs. 1, 1 a—w, 2, 2 a—f; Pl. 30, Fig. 1; Pl. 31, Figs. 3, 3 a—c; Pl. 35, Figs. 4, 4 a—b. (Exhaustively described and discussed. Of the Figs., a ventral valve from the Œlandicus beds at Borgholm.)

Horizon and locality. This species appears in the basal strata of the Œlandicus beds, persists through the Middle and Upper Cambrian and ascends into the Ceratopyge beds. Widely distributed in North-Western Europe and the Atlantic province of North America. It is not infrequent in the lower part of the Œlandicus beds of Öland, but rare in the middle and upper parts of the unit.

Lingulella (?) sp.

Three defective shells, lacking the beak, resemble *L. ferruginea* in general form but are distinct from it in having strongly marked concentric striae. Length about 8 mm. Zone of *Par. insularis.* Öland: Mossberga; Stora Frö.

Family **Acrotretidae** SCHUCHERT.

Genus **Acrothele** LINNARSSON, 1876.

Subgenus *Redlichella* WALCOTT, 1908.

Acrothele (*Redlichella*) *granulata* LINNARSSON, 1876.

Acrothele granulata, Linnarsson, 1876 a, p. 24, Pl. 4, Fig. 51, 52. (Described and discussed as a new species. Figs. of a ventral valve from Lillviken, Brunflo, Jämtland, and a dorsal valve from Borgholm, Öland.)
Acrothele granulata, Linnarsson, 1877, p. 373 (22), Pl. 15 (2), Fig. 12. (Revised description; Fig. of a ventral valve from Öland.)
Acrothele (*Redlichella*) *granulata*, Walcott, 1912 b, p. 663, Pl. 56, Figs. 2, 2 a—n. (Described and compared with *A. coriacea* LINRS. and *Botsfordia granulata* [REDLICH]. Figs. of the exterior and interior of dorsal and ventral valves from Swedish localities.)

Horizon and locality. In Öland, this species appears in the lowest part of the Œlandicus beds and continues through these beds into the basal layer (conglomerate of *A. granulata*) of the Tessini beds where it is very common but then seems to vanish. It also occurs in the Œlandicus beds of Östergötland, Närke, Jämtland, and in the Mjösen area of Norway as well as in a glauconitic-phosphoritic, coarse, calcareous sandstone forming a thin layer at the base of the Tessini beds at Kinnekulle, Västergötland. Walcott records it from the upper part of the Forchhammeri beds (zone of *Lejopyge laevigata*) too, at Gudhem in Västergötland. — Widely distributed and fairly common in the Œlandicus beds of Öland.

Genus **Acrotreta** KUTORGA, 1848.

Acrotreta schmalenseei WALCOTT, 1902.

Acrotreta socialis, Linnarsson, 1876 a, p. 16, pl. 3, Figs. 32—35. (Described and discussed. Figs. of the exterior and interior of the ventral valve and the exterior of a dorsal valve from the Œlandicus beds at Borgholm.)
Acrotreta schmalenseei, Walcott, 1912 b, p. 709, Pl. 70, Figs. 1, 1 a—s. (Description of 1902 cited. Figs. of the exterior and interior of a number of ventral and dorsal valves from the lower part of the Forchhammeri beds [the Andrarum limestone] at Andrarum, Scania.)

Remarks. This form was identified by Linnarsson as *A. socialis*, though it was said not to agree in every respect with v. Seebach's description and figures of the latter. Walcott, on the contrary, regarded it as a distinct species. In the exterior of the ventral valve the most conspicuous difference seems to be found in the median groove of the false area which, in *A. socialis*, is strong and rather broad, and, in *A. schmalenseei*, absent or faint and shallow.

In the Œlandicus beds of Öland are found specimens which wholly agree with Walcott's descriptions and figures of both these forms, but there seem to exist intermediate forms as well. However, the present material is insufficient to prove whether these two species are so clearly distinct as they are claimed to be by Walcott.

Horizon and locality. *A. schmalenseei* appears in the lowest part of the Œlandicus beds and continues through the Tessini beds into the Forchhammeri beds of Scandinavia. For localities in Öland, see the Table on p. 62. — In some layers not infrequent.

Acrotreta socialis v. SEEBACH, 1865.

Acrotreta socialis, von Seebach, 1865, p. 341, Pl. 8 a, Figs. 1—4. (Described and discussed as a new species. Figs. of the exterior and interior of ventral valve and cast of dorsal valve from the Forchhammeri beds on Bornholm, Denmark.)
Acrotreta socialis, Walcott, 1912 b, p. 711, Pl. 73, Figs. 3, 3 a—c, 4, 4 a—e. (Described and discussed. Figs. of the exterior and casts of the interior of ventral and dorsal valves form the Œlandicus beds at Borgholm and Figs. of cast of the interior of a ventral valve from the lower part of the Forchhammeri beds at Andrarum, Scania.)
Non:
Acrotreta socialis, Linnarsson, 1876 a, p. 16, Pl. 3, Figs. 32—35 (see *A. schmalenseei*).

See the preceding species.

Horizon and locality. Œlandicus beds of Öland (p. 62). Forchhammeri beds: Andrarum, Scania; Lovened, Västergötland; Bornholm, Denmark. — Rather infrequent in the Œlandicus beds.

Orthoid brachiopod.

A single defective valve lacking its posterior portion but, as far as it is preserved, resembling *Oligomys* (»*Orthis*») *exporrecta* (LINNARSSON) has been found in the Œlandicus beds (probably zone of *Par. insularis*) at Borgholm.

Gastropoda.

Family **Palaeacmaeidae** GRABAU & SHIMER(?).

Œlandia pauciplicata n. gen. et n. sp. Pl. VIII, Figs. 6, 7.

Helcionella pauciplicata, Westergård, 1929, p. 7. (Listed only.)

Description. A flattened conical, bilaterally asymmetrical univalve; apex bent towards one end of the shell, situated a little within the margin, strongly incurved. Aperture narrow, elongate, ovate, apparently pointed at the end towards which the apex curves, and rounded at the opposite extremity; on side-view, strongly convex in the region under the apex, and slightly convex or almost straight towards the opposite end. Outline of the slope under the apex strongly concave, outline of the opposite slope convex, with increasing rate of curvature towards the apex. Convex slope evenly rounded transversely, without keel. Side of the shell traversed by a uniform series of prominent ribs separated by broad grooves. Ribs rounded and rather wide at the convex margin, become narrower, higher, and sharp-edged at the middle of the shell and die out before reaching the concave margin; ribs of one side lie just opposite the grooves of the opposite side.

Test calcareous, thick; in Fig. 7 it was found to be 0.48 mm at the summit of a rib and 0.22 mm in the adjacent groove. Surface covered by fine striae parallel to the undulations.

Dimensions. The holotype, one of the largest specimens, 11.5 mm long at the aperture, and 7.5 mm high.

R e m a r k s. In specimens with the test preserved, the ribs are obliterated at the convex margin, in internal casts they continue across the convex slope a short distance into the groove on the opposite side, and, sometimes, become divided into two small branches before smoothing out. Consequently, in specimens with the test preserved, the convex slope forms, on side view, an evenly curved line, an undulating line in internal casts. Even in the largest specimens present, only eight ribs are developed. In consequence of the varying thickness of the test, the ribs are markedly more angular in specimens with the test preserved than in internal casts.

A f f i n i t i e s. Originally, the writer referred this species to the Cambrian gastropod genus *Helcionella* GRABAU & SHIMER (1909) which it resembles fairly well on side view, and its thick calcareous shell was, too, in accord with that interpretation. However, when the specimen shown in Fig. 7 had come to hand, its shell proved to be bilaterally asymmetrical in respect to the arrangement of the ribs, the species accordingly being quite distinct from that genus. Nor is the species referable to *Stenotheca* (SALTER MS.) HICKS, 1872, in which the species now referred to *Helcionella* were formerly included and which now are considered to belong to the Branchiopoda. The genotype of *Stenotheca, S. cornucopia,* has recently been subjected to a close examination and redescription by Dr. Cobbold (1934), according to whom its shell probably is bilaterally symmetrical and, at any rate, its test very thin and distinct from that of the Swedish species. Thus it seems justifiable to give the latter a new generic name. Tentatively, this new genus is included in the cone-shaped gastropoda.

It may be remarked that *Œ. pauciplicata* recalls the recent heteropod genus *Carinaria* in the zigzag arrangement of the ribs, and also in the general form of the shell, a fact to which Dr. N. Hj. Odhner has kindly called the writer's attention.

H o r i z o n a n d l o c a l i t y. Zones of *Par. insularis* and *Par. pinus.* Öland: Borgholm; Stora Frö, 7 km NNE of Mörbylånga. — Very rare.

Family **Hyolithidae** NICHOLSON.

In his monograph on the Swedish Cambrian-Silurian *Hyolithidae* and *Conularidae,* Holm, in 1893, described three species of *Orthotheca* and three of *Hyolithes* s. s. from the Œlandicus shale of Öland. Since that time no specimens of these forms in a better state of preservation have been collected, and so, the writer will content himself with referring to Holm's monograph where these forms are carefully described and depicted. Their vertical and regional distribution in Öland, in so far as it is known at present, may be seen from the Table, p. 62.

Trilobita.

Family **Condylopygidae** RAYMOND, pars. (Section *Regii* TULLBERG).

Genus **Condylopyge** CORDA, 1847.

Condylopyge regia (SJÖGREN, 1872). Pl. I, Figs. 1—3.

Agnostus regius, Sjögren, 1872, p. 76, Pl. 5, Fig. 6. (Description and a rough figure of a complete specimen.)
Agnostus regius, Linnarsson, 1877, p. 21 (372), Pl. 2 (15), Figs. 9, 10. (Description and figures of cephalon and pygidium.)

Horizon and locality: In the core from Mossberga, this species has been found only in the zone of *Par. insularis*, and as it is associated with the latter at other localities, too, of Öland, we may infer that it is confined to this zone. Also known from Brunflo in Jämtland (boulders). — Not infrequent in Öland.

Condylopyge carinata n. sp. Pl. I, Figs. 4—8.

Description. As regards cephalon and thorax *C. carinata* agrees with *C. regia.* The axis of the pygidium is raised into a keel which is most prominent in the posterior part of the third ring, continues into the second ring but is obliterated in the first ring. Lateral lobes narrow, slope continuously to the broad and shallow marginal furrow. A faint longitudinal furrow behind the axis is sometimes visible, but usually indiscernible. Marginal rim wide and moderately arched.

Dimensions. A complete full-grown specimen from Borgholm is 8.0 mm long (cephalon 3.6, thorax 1.1, pygidium 3.3) and 3.3 mm broad across cephalon and pygidium.

Affinities. *C. carinata* is closely allied to *C. regia* with which it has indeed been identified. The differences regarding the pygidium are conspicuous, however. Thus, the oblique grooves of the lateral lobes, sharply marked in *C. regia*, are absent in *C. carinata*, and the keel of the axis of the latter is replaced in the former by a small slightly elongate tubercle which does not continue beyond the third ring. In several respects, *C. carinata* is intermediate between *C. regia* and *C. rex* from the Tessini beds.

Foreign forms closely allied to *C. carinata* are *C. regulus* (Matthew, 1896, p. 213) from the zone of *Par. lamellatus* of Canada, and *C. regia globosa* (Illing, 1916, p. 419), from the Lower *Par. hicksi* zone of the Stockingford shales of England. The Swedish form is distinguished from them both *inter alia* by its wider marginal rim.

Horizon and locality. Zone of *Par. pinus*. Öland: Mossberga (boring core) and Borgholm. — Rather infrequent.

Family **Peronopsidae** n. (Section *Fallaces* TULLBERG).

Genus **Peronopsis** CORDA, 1847.

Peronopsis integra (BEYRICH, 1845), P. I, Figs. 16—18.

Agnostus integer, Barrande, 1852, p. 900, Pl. 49. (Exhaustive description and figures of complete specimens at different stages of growth from Bohemia.)

Remarks. The figured specimens, the only ones present, agree perfectly with the Bohemian species. Fig. 16 is somewhat worn and, accordingly, does not show the tubercle on the glabella, nor the one on the axis of the pygidium. Figs. 16 and 18 represent the broad form, Fig. 17 the narrow one. Figs. 17 and 18, which show a pair of very small marginal spines, are referable to the form which Pompeckj (1895, p. 522) distinguished as a variety under the name of *A. integer spinosus*.

The specimens which belong to the Palaeozoological Department of the State Museum are preserved in a dark-grey, almost black, arenaceous shale, and are labelled »Vickleby, Öland». A similar rock forms thin layers in the lowest part of the Œlandicus beds of Öland (in the boring cores from Borgholm and Mossberga and on the shore N of Stora Rör) but is not represented in the collections of Œlandicus shale from Vickleby. It may be remarked, however, that the slabs are also lithologically identical with a couple of slabs carrying *C. integra* from Jinec in Bohemia which are kept in the museum just mentioned. Provided that the specimens were actually collected in Öland and that no change of labels has taken place, a possibility not to be lost sight of considering the lithological character of the rock, they originate from the lowest part of the Œlandicus beds which, otherwise, has yielded only a few fragments of *Paradoxides* in addition to some Brachiopoda.

Peronopsis fallax (LINNARSSON, 1869). Pl. I, Figs. 9—15.

Agnostus fallax, Linnarsson, 1869, p. 81, Pl. 2, Figs. 54, 55. (Description and figures of the form predominant in the lower part of the Tessini beds of Västergötland.)

Agnostus fallax, Linnarsson, 1877, p. 20 (371), Pl. 2 (15), Fig. 7. (Figure of a nearly complete specimen from the Œlandicus beds at Borgholm, Öland.)

Agnostus fallax forma 1, Brögger, 1878, p. 48 (64), Pl. 6, Fig. 1. (The form of the Tessini beds at Krekling described and distinguished from allied forms from other horizons; figure of a complete specimen.)

Agnostus fallax forma typica, Tullberg, 1880, p. 31, Pl. 2, Fig. 22. (The form from the lower part of the Tessini beds at Andrarum described and depicted.)

Agnostus fallax, Strand, 1929, p. 346, Pl. 1, Fig. 19. (Description and figure of the form occurring in the Tessini beds of the Mjösen area.)

Remarks. Under the specific name of *P. fallax*, a series of closely related forms has been brought together, which often seem to be rather sharply distinct but which, whenever a large number of specimens is present, are found to be connected by intermediate forms. The differences are conspicuous mainly in the pygidium. The form from the Œlandicus beds agrees fairly well with the type of the species occurring in the lower part of the Tessini beds. In the former, the pygidial axis is always long and reaches, either entirely or nearly so, to the marginal rim, as is the case in the latter too. In specimens with relatively shorter axis the lateral lobes are, as a rule, separated by a longitudinal furrow and are rarely confluent as is the case in *forma ferox* TULLBERG. Of other forms, one especially, occurring in the Forchhammeri beds, resembles that of the Œlandicus beds, the principal difference consisting in the glabella and the pygidial axis being somewhat narrower in the former than in the latter.

Dimensions. The form occurring in the Œlandicus beds is comparatively small, the average length of cephalon and pygidium being about 3 mm, or even less. The largest specimen found, a pygidium, is 4.6 mm long.

Horizon and locality. Zone of *Par. pinus*. Fairly common at all localities in Öland with this zone accessible. Found associated with *P. pinus* also in Jämtland. Extensively distributed in the Tessini beds in Scandinavia, in their lower parts at least.

Family **Agnostidae** JAEKEL.

Genus **Agnostus** BRONGNIART, 1822.

Agnostus gibbus praecurrens n. var. Pl. I, Figs. 19—23.

Agnostus gibbus, var., Linnarsson, 1877, p. 20 (371), Pl. 2 (15), Fig. 8. (Description and figur of a pygidium.)

Description. Glabella subcylindrical, inconsiderably widened backwards, posteriorly moderately convex; basal lobes small, equilaterally triangular. Longitudinal furrow in front of the glabella weak (usually distinct in internal casts but sometimes indiscernible in external moulds). Cephalic spines absent. Pygidial axis with a blunt tubercle on the second ring; lateral lobes usually confluent behind the axis, occasionally (especially in young specimens) separated by a faint furrow.

Dimensions. The largest cephalon is 5.8 mm long and 6.2 mm wide, the largest pygidium 6.2 mm in length and 6.7 mm in width.

Remarks and Affinities. The typical form of *A. gibbus* LINNARSSON, 1869, originates from the lower part of the Tessini beds in Västergötland, and specimens which may be syntypes are kept in the collections of the Geological Survey. In some details this form has never been fully described and depicted: the posterior margin of the cephalon sends out a pair of slender spines, and the pygidial axis is provided with a short, coarse, conical spine directed backwards and upwards. As the spines generally get broken when the rock is split, it is easy to conceive that they were overlooked by Linnarsson and subsequent authors, in spite of their forming a constant character.

The variety *praecurrens* is closely related to the species, an ancestral form of which it may be. The former is distinct from the latter in being without cephalic spines, by the posterior part of the glabella being less strongly convex, the pygidial axis provided with a blunt tubercle instead of a short spine, and the longitudinal furrow behind the axis being (almost) obliterated. There also exists a slight difference in the dimensions: in *A. gibbus praecurrens*, cephalon and pygidium are a little wider than long, whereas, in *A. gibbus* s. s., cephalon as well as pygidium are of equal length and width.

A. gibbus praecurrens presents a still closer resemblance to *A. gibbus hybridus* BRÖGGER (1878) but does not appear to be identifiable with the latter on account of the following differences: the tubercle on the axis of the pygidium is, in the former, comparatively small and does not continue beyond the middle lobe; in the latter it is elongated and projects into the posterior lobe; the former, again, is less strongly arched, especially in the pygidium, and slightly wider in proportion than the latter. — A form from the Œlandicus beds of the Mjösen area of Norway, which Strand (1929) identified as *A. gibbus hybridus*, may possibly be included in *A. gibbus praecurrens*.

Dr. Howell (1935 c) regards *A. gibbus* as the genotype of a distinct genus, called *Triplagnostus*. However, as far as the writer can see the differences between *A. gibbus* and *A. pisiformis* (L.), the genotype of *Agnostus* s. s., appear to be of no importance for distinguishing these species generically.

Horizon and locality. Zone of *Par. pinus*. Öland: Borgholm; Mossberga; Mörbylånga. Also found in corresponding strata in Jämtland. — Rather infrequent.

A. gibbus s. s. is confined to the lower part of the Tessini beds, i. e., the zone of *Ctenocephalus exsulans* and adjacent strata, and is widely distributed in Scandinavia. — *A. gibbus hybridus* has been found in Sweden only in the middle part of the Tessini beds, associated with *Hypagnostus parvifrons mammillatus* (BRÖGGER).

Family **Eodiscidae** RAYMOND.

Genus **Calodiscus** HOWELL, 1935.

Calodiscus œlandicus n. sp. Pl. I, Figs. 24—26.

Microdiscus sp., (Moberg) Wiman, 1906, p. 90. (Listed only.)
Goniodiscus (?) *œlandicus*, Westergård, 1929, p. 7. (Listed only.)

Description. Cephalon broadly semicircular. Glabella moderately conical and convex, occupies about one-fourth the width and two-thirds the length of the cephalon (the occipital spine not included), separated from the marginal rim by a broad marginal furrow, bounded by well-marked axial furrows, without glabellar furrows and occipital furrow, prolonged into a stout occipital spine which is bent downwards at the tip. Cheeks strongly convex, separated in front of the glabella. Marginal rim very broad in front, narrowing rapidly to the genal angles, ornamented by a row of rounded knobs which are large in front, decrease in size backwards and are obliterated at the genal angles.

Of the thorax, only the last segment attached to the pygidium is known. Axis strongly convex, probably raised into a tubercle or spine.

Pygidium semielliptical. Axis about one-fifth the total width in front, convex, slightly conical, extends to the marginal rim, bounded by distinct narrow axial furrows, divided into six rings besides the terminal portion. (The third ring seems to be strongly convex and to project high above the adjacent rings.) Lateral lobes with five distinct furrows separating rounded ribs. Marginal rim rather broad and flat at the sides, narrow and somewhat convex behind.

Test of cephalon and pygidium closely granulated in the projecting parts, the occipital spine inclusive, smooth in the glabella and in the furrows.

Dimensions. Cephalon 2.5 mm long and 3.3 mm broad; pygidium 1.9 mm long and 3.1 mm broad.

Remarks. Only the specimens figured have been found. Although the pygidium was collected at a locality 1 km SW of Mörbylånga church and about 32 km S of Mossberga, the finding-place of the cephala, it can scarcely be doubted that the former belongs to the same species as the latter, since the former, too, was found in the topmost strata of the Œlandicus beds.[1]

Affinities. Of the *Eodiscidae* hitherto found in Sweden only one more, as yet undescribed, species from the lower Tessini beds in Northern Jämtland belongs to genus *Calodiscus* (*Goniodiscus* RAYMOND, 1913). In the pygidium these two forms are almost alike, but in the cephalon they are readily distinguished: *C. œlandicus* has a long glabella and the marginal rim broad and provided with large and few knobs, the form of the Tessini beds has a short glabella and the rim narrow and crenulated throughout, with a series of small and numerous beads.

On the other hand, two foreign species are more closely allied to *C. œlandicus*, viz. *C. sculptus* (HICKS) from the *Paradoxides harknessi* zone of South Wales and *C. dawsoni* (HARTT) from the *P. bennetti* zone of Newfoundland and the *P. lamellatus* zone of New Brunswick, Canada, both of them occurring in strata which may be approximately correlated with the Œlandicus beds of Sweden. Unfortunately *C. sculptus* is too imperfectly known (see Lake, 1907, p. 35) to allow of a thorough comparison. Even if any characteristics which safely distinguish this form from *C. œlandicus* can, at present, hardly be pointed out, it would seem appropriate to keep them apart until further investigations have been made. Judging from the descriptions and illustrations by Walcott (1884, p. 23) and Matthew (1896, p. 240) the American form differs from the Swedish one principally by having somewhat longer glabella which reaches to the marginal furrow.[2] Evidently, the differences between *C. œlandicus*, *sculptus*, and *dawsoni* are unimportant, and, possibly, future investigations of better preserved material will show the Swedish and Welsh forms to be synonymous.

Horizon and locality. Zone of *Par. pinus*. Öland: Mossberga and Mörbylånga (1 km SW of the church). — Rare.

[1] The pygidium was found associated with *Paradoxides pinus*, *P. torelli*, *P. bidentatus*, *Ellipsocephalus polytomus*, and *Agnostus gibbus praecurrens*.

[2] It should be noticed, however, that, in the illustration by Dawson (Acadian Geology, sec. edit., 1868, p. 654) the glabella does not touch the marginal border, and is of about the same length as in the Swedish form.

Family **Burlingidae** Walcott.

Genus **Burlingia** Walcott, 1908.

Burlingia lævis Westergård, 1929. Pl. XII, Figs. 8, 9.

Burlingia laevis, Westergård, 1929, p. 7. (Characterized as a new species and compared with *B. hectori* Walc. No illustration.)

Description. Dorsal shield ovate, very gently convex; ratio of length and breadth 8 : 5; axial furrows shallow. Cephalon semicircular; genal angles extend slightly backward, acute; a clearly defined rim absent, but the anterior margin is raised into a very narrow thread-shaped ridge which is almost obliterated at the lateral margin. Palpebral lobe one-third to one-fourth the length of the cephalon, situated a little behind the centre and close to the axial furrow, somewhat elevated along its outer margin. Glabella gently convex, about three-fourths the length of the cephalon, almost parallel-sided, slightly tapering in front of the eyes, rounded in front, indistinctly limited from the preglabellar field, devoid of glabellar furrows and pits. Occipital furrow or segment indiscernible; a short occipital spine or tubercle is present. Free cheeks subquadrangular, increasing slightly in width outwards. The posterior branch of the facial suture cuts the lateral margin some distance in front of the genal angle, and runs directly inward and slightly backward to the eye; the anterior branch continues from the eye in a straight line outwards and forwards to the anterolateral margin.

Thorax of fourteen segments; axis gently convex, smooth; pleura flat, curving backward in their extremities, truncate, with the posterior termination acute; pleural furrows direct, very shallow and wide.

Pygidium small, elongate, without defined segments; posterior margin truncate.

Test smooth.

Dimensions. The holotype, a large specimen, is 13 mm (cephalon 3.8, thorax 6.8, pygidium 2.4) in length and 8.3 mm in width.

Remarks. Two specimens, 10 and 13 mm in length respectively, have fourteen thoracic segments. In a specimen 7 mm long the number of segments seems to be twelve. All specimens found are preserved in shale and possibly slightly flattened owing to pressure.

Affinities. *B. lævis* is very closely related to the genotype, *B. hectori* Walcott, from the Middle Cambrian Ogygopsis shale of the Stephen formation of British Columbia, the only species of this genus yet described (Walcott, 1908, p. 14). The Swedish form seems to differ from the Canadian mainly in having the glabella entirely without furrows and pits, but provided with a small occipital spine or tubercle; by the outline of the thorax forming an unbroken (not dentate) line, and by its somewhat larger size, the largest Canadian specimen measuring only 7 mm in length. The differences are evidently unimportant and may, in part, be possibly due to different modes of preservation.

Horizon and locality. Known only from the zone of *Par. pinus* in Öland. Three, more or less, complete specimens and two fragments have been found in the core of Mossberga, and, at a well-sinking at Borgholm, five fairly complete specimens and a few cranidia, all of them associated with *Par. pinus*, were collected by G. Holm in 1889.

Family **Paradoxidae** EMMRICH.

Genus **Paradoxides** BRONGNIART, 1822.

Paradoxides œlandicus SJÖGREN, 1872. Pl. II, Figs. 1—11; Pl. III, Figs. 1—6.

Paradoxides œlandicus, Sjögren, 1872, p. 72, Pl. 5, Fig. 1. (Description emphasizing the differences between this species and *P. tessini;* schematic figures of a cephalon with attached incomplete thorax and a disjointed pygidium, from Stora Frö [or Borgholm].)
Paradoxides œlandicus, Linnarsson, 1877, p. 3 (354), Pl. I (14), Figs. 1—6 (Thorough description and figures of cephalon, incomplete thorax and pygidium; new figure of Sjögren's Fig. 1.)

Linnarsson's description can be supplemented in some respects by the aid of more fully preserved material.

Thorax has 17 segments. Four rather complete specimens, varying in length between 35 and 65 mm have this number; in a fifth specimen, 17.5 mm long, the thoracic segments are 16 only. In the anterior and middle segments the pleuron is slightly contracted at the fulcrum, owing to the posterior margin forming an abrupt but gentle incurvation; in the hindmost segments, the pleuron, on the contrary, is somewhat expanded beyond the fulcrum. The inner part of the pleuron, between the axial furrow and the fulcrum, is about two-thirds the width of the axis and occupies about one-third — in the posterior segments about one-fourth — of the total length of the pleuron.

The pygidium is liable to some variation. The predominant form has two pairs of points or very short spines the inner pair of which are weaker than the outer, and it attains its greatest breadth behind the middle. In some specimens the spines are somewhat longer; rarely, a third pair of points are indicated, and the maximum width occasionally lies approximately across the middle. The axial lobe is indistinctly limited from the lateral lobes, and is sometimes a little longer than in Figs. 5 and 6 of Pl. III.

Hypostoma convex and widened anteriorly, posterior margin slightly incurved, with a pair of strong, backwardly directed spines and a pair of distinct maculae. It is connected to the rostrum by a suture, and, consequently, hypostoma and rostrum are, as a rule, found separate.[1]

Ontogeny, see p. 51.

Dimensions. A complete specimen is 46 mm long (cephalon 16, thorax 24, pygidium 6) and about 34 mm wide across the thorax. The largest cranidia found are 50 mm, indicating a total length of about 150 mm. Compare also the Table.

[1] Rostra of *Paradoxides* are by no means rare in the Œlandicus shale but occur almost exclusively quite separately; only exceptionally are they found in their original position in relation to the hypostoma, as is the case in Pl. VI, Fig. 15. Thus, in these *Paradoxides* forms the hypostomal suture is well developed (as seen, too, in Fig. 15), and is not evanescent as it is in one or more forms of *Paradoxides* of the Tessini beds, in which hypostoma and rostrum are more or less completely fused into one plate. — Compare also Henriksen, 1926, pp. 14—15, and Poulsen, 1927, p. 320.

Measured specimens	*Paradoxides*					
	Specimens in shale					
	No. 1 II: 1	No. 2 II: 3	No. 3 II: 4	No. 4 Mossberga, level 11.9 m	No. 5 II: 6	No. 6 II: 10
Length of cranidium . . .	2.6 mm (1)	5.6 mm (1)	6.6 mm (1)	9.6 mm (1)	15.6 mm (1)	18.4 mm (1)
Breadth of cranidium across the palpebral lobes . .	3.1 (1.19)	6.6 (1.18)	7.7 (1.17)	11.0 (1.15)	17.2 (1.10)	20 (1.09)
Length of glabella + occipital ring	2.0 (0.77)	4.8 (0.86)	5.5 (0.83)	8.3 (0.86)	14.0 (0.90)	16 (0.87)
Breadth of glabella across the frontal lobe	1.2 (0.46)	3.0 (0.54)	4.4 (0.67)	5.6 (0.58)	9.5 (0.61)	11 (0.60)
Breadth of glabella across the posterior lobe . . .	1.05 (0.40)	2.4 (0.43)	3.1 (0.47)	4.7 (0.49)	6.9 (0.44)	8.3 (0.45)
Length (chord) of palpebral lobe	1.0 (0.38)	2.6 (0.46)	3.2 (0.48)	4.5 (0.47)	7.0 (0.45)	7.8 (0.42)

Remarks and Affinities. *P. œlandicus* occurs associated with some very closely related forms, viz. *P. quadrimucronatus, bidentatus,* and *pinus,* and, if only disjointed parts of the dorsal shield are in hand, it seems

Fig. 8. Free cheek, probably of *Paradoxides œlandicus*, or a closely related species, showing a small but prominent boss inside the posterior marginal rim. Nat. size. Mörbylånga (boulder). Compare Pl. X.

often impossible to ascertain which of these forms is present. This remark has reference to the cephalon and, in part, to the thorax too; only in the pygi-

œ l a n d i c u s							*P. bidentatus*
		Specimens in limestone					in limestone
No. 7 III: 2	No. 8 Borgholm	No. 9 II: 5	No. 10 St. Frö	No. 11 St. Frö	No. 12 III: 1	No. 13 St. Frö	No. 1 Björsholm, Närke
32.4 mm (1)	44 mm (1)	7.6 mm (1)	15.0 mm (1)	22.1 mm (1)	27.4 mm (1)	33.5 mm (1)	27.4 mm (1)
35.8 (1.10)	48 (1.09)	8.6 (1.13)	16.8 (1.12)	25.2 (1.14)	28.2 (1.03)	38 (1.13)	30.0 (1.09)
29.7 (0.92)	41.7 (0.95)	6.9 (0.91)	13.7 (0.91)	20.6 (0.93)	24.8 (0.91)	30.5 (0.91)	24.5 (0.89)
21.5 (0.66)	30 (0.68)	4.0 (0.53)	9.7 (0.65)	13.5 (0.61)	16.2 (0.59)	21 (0.63)	17.0 (0.62)
15.8 (0.49)	21 (0.48)	3.2 (0.42)	7.2 (0.48)	10.9 (0.49)	12.0 (0.44)	16.0 (0.48)	13.0 (0.47)
12.5 (0.39)	16.2 (0.37)	3.7 (0.49)	6.6 (0.44)	9.0 (0.41)	11.4 (0.42)	14 (0.42)	11.7 (0.43)

dium and, as it would seem, in the hindmost thoracic segments, are the distinctions obvious.

Sjögren's Fig. 1, the holotype, re-illustrated by Linnarsson and in the present paper too (Pl. II, Fig. 10), is labelled »Öland» only and, consequently, the actual finding place is unknown, but as Sjögren recorded the species only from Stora Frö and Borgholm, the locality must be one of the two. The lithological character of the slab — a fairly arenaceous shale — indicates that, in all probability, it originates from the zone of *P. insularis*.

Linnarsson's description applies very well to *P. œlandicus* in the narrow sense used here, and it seems probable that he had before him specimens of this form only. His description was founded principally on well-preserved but incomplete specimens in limestone from Stora Frö, and, to a minor extent, on not very perfectly preserved specimens in shale from Stora Frö and Borgholm. At the former locality only *P. œlandicus* and *P. sjögreni* (which latter, even in fragments is readily distinguished from the former) seem ever to have been found.

Horizon and locality. Ranges through the bulk of the Œlandicus beds of Öland and seems to occur numerously especially in the upper part of the *P. insularis* zone. It continues into the upper zone but is soon superseded by *P. pinus*. Occurs in Jämtland too, and probably in Östergötland, Närke and Ångermanland-Lapland. Recorded also from the Mjösen area of Norway. — Common.

Paradoxides quadrimucronatus HOLM MS. Pl. III, Figs. (7?), 8—9.

Paradoxides sp. indet. Linnarsson, 1877, p. 11 (362), Pl. 1 (14), Fig. 12. (Description and figure of an incomplete pygidium from the Œlandicus beds at Borgholm.)

Remarks. As yet, this form is known with full certainty only from the pygidium, fourteen specimens of which have been found. The pygidium recalls

Measured specimens	Specimens					
	No. 1 IV: 6	No. 2 IV: 12	No. 3 IV: 21	No. 4 V: 3	No. 5 V: 7	No. 6 V: 11
Length of cranidium . . .	0.84 mm (1)	1.12 mm (1)	1.55 mm (1)	2.36 mm (1)	3.8 mm (1)	6.1 mm (1)
Breadth of cranidium across the palpebral lobes . .	0.97 (1.15)	1.31 (1.17)	1.76 (1.14)	2.66 (1.13)	4.6 (1.21)	7.6 (1.25)
Length of glabella + occipital ring	0.75 (0.89)	0.97 (0.87)	1.20 (0.77)	1.76 (0.75)	3.1 (0.82)	5.3 (0.87)
Breadth of glabella across the frontal lobe	0.41 (0.49)	0.45 (0.40)	0.64 (0.41)	0.97 (0.41)	2.1 (0.55)	3.8 (0.62)
Breadth of glabella across the posterior lobe . . .	0.26 (0.31)	0.37 (0.33)	0.52 (0.34)	0.86 (0.36)	1.7 (0.45)	2.9 (0.48)
Length (chord) of palpebral lobe	0.37 (0.44)	0.45 (0.40)	0.67 (0.43)	1.05 (0.44)	1.5 (0.40)	2.9 (0.48)
Length of dorsal shield spines not considered .	—	1.5 (1.34)	2.7 (1.74)	—	c. 8.5 (2.24)	—

that of *P. œlandicus*, but differs by being more elongate, markedly longer than broad, and in having long and coarse spines. Two pairs of spines occur (in one specimen three pairs are present?). The outer spines which are always longer than the inner ones, occupy from one-third to one-fourth of the total length. Axis short, conical and blunt, posteriorly not sharply limited from the lateral lobes; has one ring. Lateral lobes flat and without traces of segmentation. Doublure broad, extends to the axis. Test smooth. The largest pygidium is 12 mm long and 8.5 mm broad.

The associated cranidia and free cheeks are not distinct from those of *P. œlandicus* and *P. pinus;* whether the associated disjointed thoracic segments agree better with the former than the latter species must be left undecided. In *P. quadrimucronatus*, as in *P. œlandicus*, the pygidium is liable to some variation, but, in spite of rather many specimens being present, a continuous series connecting the former to the latter cannot be adduced. Even in fairly young specimens the distinctive characters are prominent. For the present, therefore, it would seem appropiate to regard them as two independent species. However, complete specimens, when found, may possibly show that the form named *quadrimucronatus* is a mere variety of *œlandicus*.

Horizon and locality. Zones of *Par. insularis* and *Par. pinus*. Öland: Mossberga and Borgholm. — Not common.

Paradoxides bidentatus n. sp. Pl. III, Figs. 12—17.

Description. This form is known with certainty only from the pygidium and part of the thorax.

Pygidium slightly broader than long, widest across the middle; axis large *p i n u s.*

i n s h a l e						Spec. in limestone	
No. 7 V: 13	No. 8 VI: 1	No. 9 VI: 2	No. 10 VI: 5	No. 11 VI: 6	No. 12 Borgholm	No. 13 associated with No. 14	No. 14 VI: 4
8.2 mm (1)	11.0 mm (1)	19.2 mm (1)	24.8 mm (1)	47 mm (1)	58 mm (1)	19.0 mm (1)	23.5 mm (1)
10 (1.22)	13.4 (1.22)	22.5 (1.17)	27.0 (1.09)	49 (1.04)	64 (1.10)	21 (1.10)	26.3 (1.12)
7.3 (0.89)	9.7 (0.88)	17.2 (0.90)	22.2 (0.90)	42 (0.89)	53 (0.91)	17.7 (0.93)	21.3 (0.91)
5.3 (0.65)	6.7 (0.61)	12.4 (0.65)	15.0 (0.60)	30 (0.64)	c. 38 (0.66)	12.0 (0.63)	15.3 (0.65)
4.2 (0.51)	4.8 (0.44)	9.3 (0.48)	10.5 (0.42)	22 (0.47)	30 (0.52)	8.0 (0.42)	10.8 (0.46)
4.0 (0.49)	5.1 (0.46)	9.0 (0.47)	10.0 (0.40)	15 (0.32)	18.5 (0.32)	8.4 (0.44)	10.3 (0.44)
24 (2.93)	—	—	—	—	—	—	—

occupying two-thirds to three-fourths the total length; is non-segmentate or with one faintly marked ring; posterior margin rounded, with a pair of short spines and, sometimes, an inner pair of more or less distinct points.

D i m e n s i o n s. One fairly large pygidium measures 21 mm in length and 23 mm in breadth; the largest pygidium found is 29.5 mm long and 31 mm broad. See also the Table, p. 35.

R e m a r k s. The cranidium probably belonging to this form resembles that of *P. œlandicus*, and differs only by the frontal lobe of the glabella being less swollen.[1] In the thorax, too, as far as it is known (Fig. 17), this form agrees with *P. œlandicus;* whether the pleura of the hindmost segments are expanded in the same manner as in that species cannot be ascertained, however. Evidently, *P. bidentatus* is very closely allied to *P. œlandicus*, but, at present, distinctions can be safely pointed out only in respect to the pygidium. About forty pygidia are present, which vary to some extent, but true intermediate forms connecting *P. bidentatus* to *P. œlandicus* do not seem to exist. Consequently, there seems to be a reason for regarding the former, at present at least, as an independent species. As may be the case in *P. quadrimucronatus*, complete specimens of *P. bidentatus*, when found, may possibly prove the latter, too, to be nothing but a variety of *P. œlandicus*.

H o r i z o n a n d l o c a l i t y. Zone of *Par. pinus* and possibly the uppermost part of the zone of *P. insularis*. Öland: Mörbylånga and Borgholm; Närke: Björsholm. Jämtland: Västerskucku: Kloxåsen; Ytterhallen. — Not infrequent.

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[1] The cranidium referred to (two specimens) was found in a limestone boulder at Björsholm in Närke, which yielded no other fragments of *Paradoxides* than two pygidia of the form in question.

Measured specimens	*Paradoxides* Specimens No. 1 VII: 1	No. 2 VII: 2	No. 3 Mossberga, level 23.4 m
Length of cranidium	5.2 mm (1)	13.7 mm (1)	15.1 mm (1)
Breadth of cranidium across the palpebral lobes .	6.6 (1.27)	16.6 (1.21)	18.0 (1.19)
Length of glabella + occipital ring	4.4 (0.85)	12.6 (0.92)	13.6 (0.90)
Breadth of glabella across the frontal lobe . . .	3.1 (0.60)	9.0 (0.66)	9.8 (0.65)
Breadth of glabella across the posterior lobe . .	2.4 (0.46)	6.8 (0.50)	7.0 (0.46)
Length (chord) of palpebral lobe	2.1 (0.40)	6.0 (0.44)	7.4 (0.49)

Paradoxides pinus Holm MS. Pl. IV—VI.

D e s c r i p t i o n. In the cephalon this species agrees with *P. œlandicus;* any safe and constant differences do not seem to exist.

Thorax with 19 segments (in five rather complete specimens between 13 and 37 mm long). Pleura prolonged into very long falcate spines. The inner part of the pleuron, between the axial furrow and the fulcrum, is about half as wide as the axis and occupies about one-fourth or one-fifth the total width of the pleuron. In the anterior and middle segments, the posterior margin is slightly incurved at the fulcrum, and the spine, even at its base, somewhat narrower (in longitudinal direction) than the inner part of the pleuron. In the most posterior segments the spine is about equal in breadth to the pleuron inside the fulcrum, and not at all, or very inconsiderably, expanded.

Pygidium narrow and elongate, the breadth being three-fourths to four-fifths the length; widest across the middle. Axis long, conical, blunt, with one or two faintly-marked rings, posteriorly often indistinctly limited from the lateral lobes, which do not show any traces of segmentation. Posterior margin entire, slightly incurved or, in young specimens, truncate. Doublure broad, reaches to the axis.

Hypostoma in all details like that of *P. œlandicus.*

D i m e n s i o n s. A complete small specimen in shale is about 25 mm long (cephalon 8.0, thorax about 14, pygidium 2.5) and 16.5 mm broad across the thorax. The largest cranidium, presumably belonging to this species is 58 mm long indicating a length of about 17 cm of the dorsal shield; the largest pygidium is 24 mm long and indicates still larger size. See also the Table, p. 36—37.

O n t o g e n y, see p. 46.

A f f i n i t i e s. It has been mentioned above that *P. pinus* is very closely

insularis					*P. torelli*	
in shale		Specimens in limestone			in shale	in limestone
No. 4 VII: 8	No. 5 Borgholm	No. 6 VII: 5	No. 7 VII: 9	No. 8 Associated with No. 7	No. 1 VIII: 1	No. 2 V. Skucku Jämtland
19.2 mm (1)	27.4 mm (1)	11.7 mm (1)	19.3 mm (1)	27.3 mm (1)	22.5 mm (1)	16.0 mm (1)
24.0 (1.25)	33.0 (1.20)	14.1 (1.21)	26.9 (1.39)	35.4 (1.30)	29.3 (1.30)	20.7 (1.29)
17.4 (0.91)	25.2 (0.92)	10.4 (0.89)	18.0 (0.93)	24.9 (0.91)	20.3 (0.90)	14.8 (0.92)
12.5 (0.65)	19.5 (0.71)	7.0 (0.60)	14.6 (0.76)	18.7 (0.68)	16.5 (0.73)	11.0 (0.69)
8.0 (0.42)	13.0 (0.47)	5.2 (0.44)	9.8 (0.51)	13.5 (0.49)	11.0 (0.49)	7.7 (0.48)
8.4 (0.44)	10.2 (0.37)	5.0 (0.43)	8.8 (0.46)	11.2 (0.41)	10.5 (0.47)	8.0 (0.50)

related to *P. œlandicus*, with which it has, indeed, been confused. When nothing but isolated parts of the dorsal shield are present, only the pygidium and probably the hindmost thoracic segments permit a safe identification.

Of foreign forms, the Bohemian *P. sacheri* BARR. presents great resemblance to *P. pinus* throughout the dorsal shield; even the number of thoracic segments is the same. The former differs from the Swedish form mainly in having a narrower thorax with comparatively wider axis and less elongate pleural spines, the axis, the inner part of the pleuron, and the spine being of about equal width (in transversal direction).

Horizon and locality. Uppermost part of the Œlandicus beds (zone of *P. pinus*). Common in Öland wherever these strata are accessible. Known from Jämtland, too, and seems to occur in the Mjösen area of Norway as well.

Paradoxides insularis n. sp. Pl. VII, Figs. 1—9.

Description. Glabella pyriform, rather inflated in its anterior part; glabellar furrows four pairs, the two posterior pairs fairly deep and broad and meeting across the glabella, the two anterior pairs short, narrow, and shallow, but distinct. Marginal rim pronounced, slightly widened at the sides, rather flat; marginal furrow shallow. Palpebral lobes long, reach to the posterior marginal furrow. Free cheek rather narrow; doublure fairly broad, occupies almost two-thirds of the space between the margin and the eye.

Number of thoracic segments unknown. Axis occupies about one-fourth the total breadth. Pleura prolonged into flat and falcate spines which, in the anterior segments, are slightly shorter, in the posterior segments, somewhat longer, than the inner part of the pleuron, and, in the hindmost segments, are expanded.

Pygidium with the length slightly greater than the breadth; posterior margin truncate or faintly rounded, non-dentate. Axis occupies about the half of the total length, has one ring.

The associated hypostoma agrees with that of *P. sjögreni.*

In the entire dorsal shield the test shows very fine and closely-set grains.

Dimensions. A middle-sized cranidium, in limestone, is 27 mm long and 35 mm broad across the palpebral lobes. The largest cranidium found, in shale, measures 36 mm in length and 42 mm in breadth. See also the Table, p. 38—39.

Remarks. *P. insularis* seems to have formerly been identified sometimes as *P. œlandicus* and sometimes as *P. sjögreni,* though it is sharply distinct from both. From *P. sjögreni* it is readily distinguished by defined marginal rim of almost uniform breadth, markedly longer palpebral lobes, and longer falcate pleural spines. It differs from *P. œlandicus* in having pyriform glabella, four pairs of distinct glabellar furrows, shorter pleural spines, and non-dentate pygidium. On the other hand, *P. insularis* presents a close resemblance to *P. torelli,* a forerunner of which it may possibly be. It differs from the latter in having the two anterior pairs of glabellar furrows well-marked, broader doublure of the cephalon, narrower thoracic axis, longer pygidium with shorter axis, and distinctly granulated test.

Horizon and locality. Confined to the zone named from this form. Öland. (For localities see p. 63.) — Not infrequent.

Paradoxides torelli HOLM MS. Pl. VIII, Figs. 1—4.

Description. Dorsal shield ovate; ratio of length, breadth across cephalon, and breadth across thorax 11: 7: 5 (holotype).

Cephalon semicircular; marginal rim of uniform breadth throughout, rather flattened. Glabella somewhat pyriform; glabellar furrows two pairs, meet across the glabella. Palpebral lobes long, extend to the posterior marginal furrow. Occipital ring with a very weak median tubercle.

Thorax of 21 segments, approximately uniform in width to the fourteenth segment. Axis occupies in the anterior segments almost one-third, in the posterior segments less than one-fourth, of the total width. Pleura prolonged into falcate spines which, in the anterior segments, have about the same, and, in the posterior segments, twice or three-times, the length of the inner part of the pleuron.

Pygidium subhexagonal, slightly wider than long, with the posterior margin gently incurved. Axis broad, posteriorly indistinctly limited, does not reach the margin, has one, rarely two, faintly marked rings. Lateral lobes flat, sometimes with a pair of furrows indicated.

Test smooth; in perfectly preserved specimens, a very fine and sparse granulation is discernible on the occipital ring and the anterior thoracic axial rings.

Dimensions. A complete, far from full-grown, specimen in shale (holotype) is 74 mm long (cephalon 23, thorax 44, pygidium 7), 49 mm across the cephalon, and 33 mm across the thorax. Larger fragments indicate a total length of at least 13 cm. See also the Table, p. 39.

Remarks. *P. torelli* seems to be sharply distinct from associated species but is closely allied to the preceeding form *P. insularis* (see p. 40).

A form from Ångermanland of which cranidium, free cheek, part of thorax, and pygidium, all in a far from perfect state of preservation, have been figured by Thorslund (Asklund & Thorslund, 1935, p. 103, pl. 2) should probably be indentified as *P. torelli*.

Horizon and locality. In Öland, probably confined to the zone of *Paradoxides pinus*. Öland: Borgholm; Mossberga, Mörbylånga. Jämtland: Väster-Skucku, parish of Berg. Ångermanland: Kvarnbäcken, near the western village of Tåsjö. — In Öland not common.

According to Strand (1929, p. 350) also found in the Mjösen area of Norway.

Paradoxides sjögreni LINNARSSON, 1877. Pl. IX, X.

Paradoxides sp. indet., Sjögren, 1872, p. 73, Pl. 5, Figs. 2—5. (Short description and rough illustrations of three incomplete cranidia and a pygidium from Stora Frö, Öland.)

Paradoxides sjögreni, Linnarsson, 1877, p. 357 (6), Pl. 14 (1), Figs. 7—9 (10?). (Fuller description and new figures of Sjögren's specimens.)

Non:

Paradoxides sjögreni, Hedström, 1923, p. 11, Pl. 2, Fig. 2. (Description and figure of a 12.5 mm long cranidium.)

Description. Dorsal shield ovate; ratio of total length and breadth across the thorax 12: 7.

Glabella pyriform, rather inflated in front; four pairs of distinct glabellar furrows, the two posterior pairs deep and broad and meeting across the glabella, the two anterior pairs shorter and shallower. Occipital ring with a weak median tubercle (sometimes indiscernible). Palpebral lobes rather small, opposite to the space between the second and fourth pairs of glabellar furrows. Brim in front of the glabella narrow and flat. Marginal rim absent or faintly marked and, in such a case, limited by a very shallow marginal furrow. Free cheek less broad than it is long (the genal spine not included); marginal rim rather flat and indistinctly limited, about as broad as the area between the rim and the eye; genal spines coarse and fairly long.

Thorax of seventeen segments (in two large specimens). Axis occupies almost one-third of the total width. Pleura prolonged into backwardly curved spines which, in the anterior segments, are very short, in the hindermost segments almost as long as the inner part of the pleuron, foliaceous to the very tips.

Pygidium subquadrate, with rounded angles, posterior margin gently curved or square; slightly widened posteriorly. Axis broad, conical, indistinctly limited, has one ring, does not extend to the margin. Lateral lobes with a pair of short and shallow longitudinal furrows.

Hypostoma anteriorly widened and fairly convex, with the posterior margin straight, has a deep and narrow groove within the posterior and postero-lateral margins, the posterior angles prolonged into a pair of short spines directed

Paradoxides sjögreni.

Measured specimens	Specimens in shale				Specimens in limestone			
	No. 1 IX: 12	No. 2 IX: 1	No. 3 IX: 8	No. 4 IX: 9	No. 5 IX: 2	No. 6 IX: 3	No. 7 IX: 5	No. 8 X
Length of cranidium	5.9 mm (1)	10.0 mm (1)	17.2 mm (1)	26.4 mm (1)	13.7 mm (1)	15.7 mm (1)	26.2 mm (1)	71 mm (1)
Breadth of cranidium across the palpebral lobes . . .	7.4 (1.25)	—	19.2 (1.12)	29 (1.10)	16.3 (1.19)	18.2 (1.16)	29 (1.11)	80 (1.13)
Length of glabella + occipital ring . .	5.0 (0.85)	8.9 (0.89)	16.3 (0.95)	24.5 (0.93)	12.7 (0.93)	14.7 (0.94)	24.4 (0.93)	6.6 (0.93)
Breadth of glabella across the frontal lobe	3.7 (0.63)	—	12.0 (0.70)	17.3 (0.66)	10.0 (0.73)	11.0 (0.70)	18.8 (0.72)	54 (0.76)
Breadth of glabella across the posterior lobe	2.9 (0.49)	—	8.2 (0.48)	12.8 (0.48)	6.9 (0.50)	7.9 (0.50)	13 (0.50)	37 (0.52)
Length (chord) of palpebral lobe .	2.0 (0.34)	3.2 (0.32)	5.0 (0.29)	7.8 (0.30)	4.6 (0.34)	5.0 (0.32)	8.0 (0.31)	20 (0.28)

outwards-backwards, exhibits a pair of distinct maculae; connected to the rostrum by a suture.

Test closely and finely granulated or, in large specimens, smooth; doublure striated.

D i m e n s i o n s. One of the largest *Paradoxides* of Sweden. An almost complete large specimen (Pl. X) is 192 mm long (cephalon 71, thorax 108, pygidium 14.5) and about 112 mm across the thorax; some fragments indicate considerably greater size, the largest pygidium (Pl. IX, Fig. 10) a total length of about 35 cm. See also Table.

O n t o g e n y, see p. 52.

R e m a r k s. The marginal rim of the cranidium is pronounced in immature forms and, as a rule, in young adults, too, in which it can occasionally be distinct on the one side and obliterated on the other side of the cranidium; in older specimens it is obsolete. The convexity of the glabella is more pronounced in smaller than in larger specimens. As pointed out by Linnarsson, the granulation of the test also becomes obliterated according to the growth of the animal; it is distinct in small specimens, is not always discernible in cranidia about 30 mm in length, and in large specimens the test is smooth.

When typically developed the pygidium is slightly widened backwards, but sometimes seems to be more strictly parallel-sided. A similar subquadrate pygidium with a pair of small marginal points (Pl. IX, Fig. 7) which was found associated with no other *Paradoxides* than *œlandicus* and *sjögreni*, should possibly also be included in the latter species.

The cranidium from Visby which Hedström (1923), with some hesitation, identified as *P. sjögreni* though it has long palpebral lobes and, as far as the present writer can see, only two pairs of glabellar furrows, certainly does not belong to this species but, more probably, to some form of the *P. œlandicus* group.

Affinities. *P. sjögreni* belongs to that group of large species which lack a distinct marginal rim at the anterior end of the cranidium, viz., *P. harlani* GREEN from Massachusetts, *P. regina* MATTHEW from New Brunswick, *P. bennetti* SALTER from Newfoundland, and *P. groomi* LAPWORTH from Shropshire. It cannot be identified with any of the latter, however, *inter alia*, because of its less wide doublure. Compare also *Paradoxides* sp. No. 1.

P. sjögreni nepos GRÖNWALL (1902, p. 118, Pl. 2, Fig. 8), known only from the cranidium, and occurring in the zone of *P. forchhammeri* of Bornholm, is characterized by a strongly marked convex marginal rim and long palpebral lobes, and can hardly be included in the group of *P. sjögreni*.

Horizon and locality. Not infrequent in the zone of *Par. insularis* and ascends into the zone of *Par. pinus*, where it is rare. Known only from Öland (see p. 63).

Paradoxides sp. No. 1 (*P. groomi* LAPWORTH?). Text-fig. 9.

A few fragments of the free cheek and the thorax of a very large *Paradoxides* are present. The free cheek is characterized by a rather small eye and an enormously broad doublure. The associated thoracic segments agree with those of *P. sjögreni*. The largest fragments indicate a total length of the dorsal shield of about 40 cm, and, accordingly, this form is the largest trilobite found in Sweden.

Though the fragments are insufficient for a safe specific identification there cannot be any doubt of this form being closely related to *P. sjögreni* and, probably, still more so to the English *P. groomi* LAPWORTH. From the former it differs in the breadth of the doublure which, even in large specimens of *P. sjögreni*, occupies only a little more than one half, in the latter, about four-fifths, of the space between the margin and the eye. Any true differences between this form and *P. groomi*, which is also imperfectly known, cannot at present be pointed out, and more complete material, when found, may possibly, prove our form to be identical with the English one or with any one of the closely allied American forms (see the preceding species).

Horizon and locality. Zone of *Par. insularis*. (Seems to be confined to the lower part of the greenish-gray arenaceous shale.) Öland: Mossberga; on the shore 2 km NNW of Ekerum.

Paradoxides sp. No. 2. Pl. VII, Figs. 10, 11.

Only the pygidium (5 specimens) is known with certainty. It is sub-elleptical in outline; ratio of length and breadth 3: 4; axis short, occupies a little more than the half of the total length, has one distinct ring and a strongly conical end lobe; lateral lobes broad, with a pair of pronounced backwardly-directed furrows which become obliterated before they reach the level of the axial point; margin entire (one specimen shows a pair of small marginal points, however).

The largest pygidia indicate very large dimensions of the complete dorsal shield, the largest specimen (Fig. 10) being 30 mm long and 40 mm broad.

To some extent, this form presents a resemblance to the pygidium of *P. sjögreni* even though it is readily distinguished by far greater breadth and a shorter and more conical axis. See also the following species.

Fig. 9. *Paradoxides* sp. No. 1. Free cheek (under-side) showing the exceptionally wide doublure. 2 km N of Ekerum. — Nat. size.

Horizon and locality. Zone of *Par. pinus*. Öland: Borgholm. — Infrequent.

Paradoxides sp. No. 3. Pl. VII, Fig. 12.

A specimen of a free cheek from the *Par. pinus* zone at Borgholm recalls the cheek of *P. sjögreni* as regards the size of the eye, but is far broader than that of the latter species and has a comparatively narrower doublure which occupies only a little more than one-third of the space between the margin and the eye.

The specimen was probably collected from the same stratum as the pygidia of sp. No. 2, and, accordingly, there are reasons for assuming it to belong to the same species as the latter, a question which cannot be decided at present, however.

Paradoxides sp. No. 4. Pl. VII, Fig. 13.

The pygidium figured, the only one of this form found, resembles *P. sjögreni* but is somewhat more parallel-sided and has a slightly shorter axis. It also compares fairly well with *P. hicksi* SALTER from the lowest part of the Tessini beds (zone of *Ctenocephalus exsulans*). Possibly it belongs to a distinct species.

Probably from the lower part of the zone of *Par. pinus*. Öland: Borgholm; well-sinking in 1894.

Ontogeny of Paradoxides.

A large material of embryonal specimens of *Paradoxides* at different stages of growth was collected by G. Holm from the zone of *Par. pinus* during a well-sinking at Borgholm in 1889, and rather many immature individuals have also been found in that zone of the boring core of Mossberga. Most of these specimens, however, consist of detached parts of the dorsal shield, mainly cranidia, whereas complete specimens are few in number. The latter represent only isolated stages of development. As, accordingly, no complete developmental series of entire specimens is present and as the associated adults belong to distinct but closely related species, the specifical identification of the youthful forms is, in some measure, doubtful.

As regards the associated adults the following facts may be noticed.

In the Mossberga core, *Paradoxides* larvae occur mainly on three levels: 6.5, 7.9, and 9.6 m beneath the surface. In this part of the core, *P. pinus* is, beyond comparison, the predominant *Paradoxides* species; 20 pygidia have been found and a very large number of detached thoracic segments, cranidia, and free cheeks are confidently referable to this species. Of fragments which cannot be included in *P. pinus*, only the following have been found in the portion of the core above the 10.8 m level; one pygidium (at the level of 10.3 m) of *P. quadrimucronatus*, three thoracic segments (at 8.5, 9.2, and 10.2 m resp.) referable to any one of *P. œlandicus*, *quadrimucronatus*, or *bidentatus*, one thoracic segment (at 8.0 m) probably of *P. torelli*, one free cheek (at 8.8 m) and two thoracic segments (at 7.9 and 8.0 m) of *P. sjögreni* type. Thus, in the thin layers to which the larvae are confined, all fragments of adults are referable to *P. pinus*, except one thoracic segment probably belonging to *P. sjögreni*.

The well-sinking at Borgholm, which was 3.5 m deep, penetrated only the *Par. pinus* zone and does not seem to have descended into its lowest portion.

Holm's collection from the well-sinking has yielded the following safely identifiable *Paradoxides* species:

P. pinus, several more or less complete specimens and more than 100 pygidia.
» *ælandicus*, 1 pygidium.
» *quadrimucronatus*, at least 1, probably 2, pygidia.
» *bidentatus*, 13 pygidia.
» *torelli*, 1 complete specimen and 8 pygidia some of which have part of the thorax attached.
» *sjögreni*, 2 cranidia.

P. pinus accordingly is, beyond comparison, the predominant species in these beds too.

The four first-mentioned species are so closely allied that their young can hardly be expected to be distinguishable until they have attained late stages of the nepionic or meraspid (Raw, 1925) period, maybe only in the earliest stage of the neanic or holaspid period. Though our knowledge of the embryonic forms of *P. sjögreni* is slight, it nevertheless indicates that even in rather early meraspid stages this species may be distinguishable from those of the *P. ælandicus* group. And of *P. torelli* larvae are as yet unknown. It should be observed, however, that the larvae of Holm's collection seem to be almost exclusively confined to a few or possibly only one bedding plane where, on the contrary, they occur abundantly, and, as practically all fragments of adults on the same slabs are referable to *P. pinus*, it seems justifiable to presume that at least the bulk of these young — as well as those from the corresponding horizon of the Mossberga core — belong to the last-mentioned species. Some of them are figured on Pl. IV and V and are numbered according to their size from the smallest upwards.

The protaspid period. The smallest individual found, a protaspis at an early stage (Pl. IV, Fig. 1), measures 0.60 mm in length and 0.75 mm in width. It is strongly arched, especially in a transversal direction. Outline broadly subcircular, nearly straight in front. Axial lobe narrow, extends to the anterior margin, sharply defined by the fairly deep axial furrows which meet in front, divided by four transverse furrows into five ring-like lobes; anterior lobe markedly wider than those back of it, and cleft by a longitudinal furrow which continues across the second lobe. Lateral lobes very convex and rise, in their anterior parts, above the axial lobe. Ocular ridges distinct, proceed from the mid-length of the frontal lobe, are separated from the latter by the axial furrows, continue in the palpebral lobes which form the lateral margins and extend to the posterior margin. Anterior margin formed by a very faint and narrow rim. The four anterior axial ring-lobes presumably constitute the glabella, the posterior one the occipital ring. Pygidium not yet developed.

A slightly larger, less perfectly preserved specimen, about 0.65 mm long and 0.82 mm wide (Fig. 2), is markedly less convex but otherwise agrees with the former.

A late protaspid stage is represented by Figs. 3 and 4. The former, which is somewhat distorted owing to compression, being bent downwards in its anterior portion, is 0.94 mm wide exclusive of the spines; the latter specimen, which is fairly arched, is 0.82 mm in total length (spines excluded), 0.71 mm in head-length, and 1.01 mm in width. Glabella rather wide and prominent, consists of three lobes about equal in width, cleft throughout by a longitudinal furrow. Occipital ring prominent, less wide than the glabella; pleura of the occipital segment faintly indicated. Ocular ridges indiscernible; palpebral lobes present. Opposite the middle glabellar lobe, a pair of short genal spines project abruptly from the lateral borders. Intergenal or metacranidial (Raw, 1925) spines stouter than the former, directed backwards and slightly outwards, extend beyond the posterior margin, seem to form the pleural terminations of the penultimate (?) cephalic segment. Transverse furrow at back of the occipital ring deeply impressed. Pygidium with a narrow axis of two or possibly three (?) rings, the anterior one prominent. Pleura of the anterior segment indicated, prolonged into a pair of backwardly-directed spines about equal in strength to the metacranidial spines. Posterior margin truncated. No sutures discernible.

Probably, Fig. 8 too represents a late protaspid stage. Total length 1.03 mm, head-length 0.90 mm, width 1.01 mm. Glabella fairly wide and prominent as in Fig. 4, consists of four lobes which gradually decrease in length from the front to the rear; frontal lobe somewhat expanded; longitudinal furrow almost indiscernible in the frontal lobe, faintly marked in the posterior lobes. Occipital lobe prominent, markedly narrower than the posterior glabellar lobe. Ocular ridges, palpebral lobes, and metacranidial spines present. Genal spines absent (free cheeks probably not yet developed). Pygidium with a very narrow axis consisting of two rings. The limit between cephalon and pygidium is marked by a furrow which is deeply impressed in the axis and extends beyond the axial furrows but does not reach the margin. No suture is discernible.

The specimen is larger than Fig. 4, but it seems doubtful whether it is more advanced than the latter, since it cannot be decided whether free cheeks existed or were still undeveloped. Lacking a suture between cephalon and pygidium and the occipital segment being indistinctly developed it is evidently more primitive than Figs. 5—7, and, as these are smaller in size, the specimen may belong to a distinct species.

The meraspid period. Of specimens next in size to Fig. 4, only cranidia are present. Fig. 5, 0.82 mm long and 0.94 mm wide; Fig. 6, 0.84 and 0.97 mm; Fig. 7, 0.88 and 0.99 mm, are similar in all essential features. Outline subquadrangular. Glabella narrow in proportion, has four lobes, the anterior of which is expanded; longitudinal furrow faint, does not continue beyond the frontal lobe. Ocular ridges and palpebral lobes distinct, the latter reaching to the base of the metacranidial spine (in these specimens broken off). Anterior marginal rim well defined. Occipital segment prominently set off from the rest of the cranidium.

In respect to the shape and lobation of the glabella, these specimens compare better with the earlier (Figs. 1 and 2) than with the later (Figs. 3 and 4) protaspid stages described above. They are believed to represent the earliest stage or Degree 0 of the meraspid period (cephalon separated by a suture from the post-cephalic segments which are all coalesced into the pygidium).

Fig. 9, 0.92 mm long and 1.05 mm wide, agrees with Fig. 7, except that the number of glabellar furrows has become complete, the foremost pair (No. 1) being faintly marked on the sides of the frontal lobe.

While, in the above-mentioned specimens, the glabella reaches to the narrow marginal furrow, in the specimens next in size it is separated from the latter by a preglabellar area which increases in breadth (in axial direction) at the same time that the cephalon increases in length. The increase of the area is also accompanied by a smoothing out of the rim, and, as a rule, the margin becomes slightly upturned. In Fig. 10, which is 0.94 mm long, the area is still very narrow, in Fig. 11, 1.05 mm long, somewhat broader, and in Fig. 12, 1.12 mm long, slightly broader than the faintly marked rim. In these specimens, the glabella tapers slightly and rather continuously backwards; the glabellar furrows No. 1 are indiscernible in Figs. 10 and 12, and very indistinctly developed in Fig. 11. The latter is one of the largest individuals in which the longitudinal glabellar furrow has been traced.

Fig. 13 shows a complete specimen in the meraspid Degree 1(?); total length not including spines, 1.50 mm, head-length 1.12 mm, width of cranidium 1.25 mm. Glabella subrectangular, very slightly expanded in front, approximately as wide as the fixed cheeks; glabellar furrows four pairs, No. 1 distinct but discontinuous, the succeeding ones traversing the glabella. Occipital ring prominent, projects behind, longer (in axial direction) than the glabellar rings, bears a blunt median tubercle. Preglabellar area about half as broad as the width of the glabella in front; marginal rim practically obliterated. Metacranidial spines long and slender, project far beyond the posterior margin of the dorsal shield. Free cheeks slightly more than half as wide as the fixed cheeks; genal spines shorter and more slender than the metacranidial, extend from the postero-lateral angles nearly in a line with the antero-lateral margins. — The single thoracic segment fairly long in axial direction; axis about equal in width to the pleura, bears a small median tubercle; pleura terminated abruptly by their outer margin, continue into exceedingly long and slender backwardly directed spines. — Pygidium consists of segments of the same character as the thoracic one; in the axis there are discernible four rings at least, and in the lateral lobes three pairs of oblique pleural furrows. Pleural spines of the anterior segment greatly prolonged, are apparently about half as long as those of the thoracic segment; spines of the posterior segments short.

Of the stages of growth next in order only cranidia are present, Figs. 15—20. They compare fairly well with Fig. 13 and do not show any continuous changes. The glabella is usually slightly more expanded in front, the breadth of the preglabellar area varies a little, and, except in Figs. 15 and 20, the marginal rim is discernible, although very faintly marked. The anterior contour, in earlier stages straight, becomes slightly curved in Figs. 19 and 20.

Figs. 21 and 22 show two complete specimens in the meraspid Degree 4. Total length, not including spines, about 2.7 mm, head-length 1.55 and 1.57

mm resp., width of cranidium in both 1.76 mm. The metacranidial spines have atrophied and are replaced by a pair of very small blunt points but, otherwise, the cranidium has not been subjected to any change. The genal spines have migrated somewhat more backwards and increased in strength, and extend quite in a line with the antero-lateral margins. In the thorax, the two anterior segments are quite like the single segment of Degree 1, their axis having a small tubercle and their pleura being produced into greatly elongated slender backwardly-directed spines which, in both segments, are about equal in length and markedly longer than the genal spines; in the two posterior segments the axis is smooth and the pleura terminate in short spines. Pygidium with six (?) axial rings and at least four, possibly five, pairs of short pleural spines.

In the following meraspid degrees, which are known only from the cranidium (Pl. V, Figs. 1—6), the preglabellar area persists broad and the glabella rather subrectangular in outline. The anterior pair of glabellar furrows (No. 1) become weaker, and No. 2 are obliterated at the middle line. At a cephalic length of about 3 mm, furrows No. 1 have disappeared as actual impressions and, at somewhat later stages, No. 2 also are rarely discernible, even though, in perfectly preserved specimens, both these pairs are recognizable as dark linear shades in the test on the sides of the glabella. Simultaneously, the glabella increases in length at the expense of the preglabellar area, and the frontal lobe becomes inflated and rounded in outline.

An almost complete specimen (Pl. V, Fig. 7) with the cranidium 3.8 mm long and the whole shield with an estimated length of about 9.3 mm, seems to represent Degree 14 (?), of the meraspid period. The preglabellar area is very narrow. Thorax (probably complete) has fourteen segments. The pleural spines are very prolonged in the second segment, otherwise they are comparatively short and equal in length to the inner part of the pleuron; directed outwards and backwards.

A specimen in the meraspid Degree 15 (not figured) consisting of the complete thorax with attached pygidium, 5.3 mm in total length, agrees with the preceding specimen, save that the pleural spines are slightly longer than the inner part of the pleuron. Pygidium with four axial rings.

Fig. 9 of Pl. V may belong to any of the last meraspid degrees (15 thoracic segments are preserved); cranidium 4.9 mm long and the length of the whole dorsal shield is estimated to have been nearly 12 mm. The cephalon agrees with that of Degree 14. The pleural spines of the second segment are still prolonged though relatively to a shorter extent than in Degree 14, and the spines of the remaining segments are one and a half times, or twice, as long as the inner part of the pleuron.

The holaspid period. Fig. 10, Pl. V, shows a complete specimen at the earliest holaspid stage observed; total length about 13.5 mm, cranidium 5.3 mm. The pleural spines of the second thoracic segment are of normal length, and the pygidium has received its definitive shape. The only remaining primitive characteristic is to be found in the length of the glabella, which does not quite reach to the marginal rim. In a somewhat larger, 6.1 mm long, cranidium (Fig. 11) even this last feature of immaturity has disappeared.

In the successive stages of growth the cephalon does not seem to be subjected to prominent and continuous changes in any special respect, excepting that the eye slightly decreases in length in the larger specimens. Thus, in specimens with cephalon less than 20 mm long, the chord of the palpebral lobe is about half as long as this; in somewhat larger specimens it is about two-fifths, and, in cephala more than 45 mm in length, about one-third of that length (cf. Pl. VI, Figs. 1—6, and the Table, pp. 36—37).

Summary of the ontogeny of Paradoxides pinus. Even if the above-mentioned larval individuals do belong to different species — which, in such a case, are undoubtedly very closely related — the evolution of *Paradoxides pinus* may be summarized as follows.

In the protaspid period, the glabella extends to the faint marginal rim and has the frontal lobe widened; becomes, at the beginning of the meraspid period, separated from the rim by a preglabellar area which rapidly increases in breadth, while, at the same time, the glabella assumes a subrectangular outline. In the later meraspid degrees the glabella again grows in length at the cost of the area, becomes at the same time widened, rounded, and inflated in the frontal lobe, and has received its definite shape at an early holaspid stage. Even in the protaspid period the glabella is bounded by well-marked axial furrows which meet in front of it and is distinctly annulated; the full number of glabellar furrows are developed in the meraspid Degree 1 at least. Contemporaneously with the growth and swelling of the frontal lobe of the glabella in the later meraspid degrees, the two anterior pairs of furrows become gradually obliterated, at first the foremost and then the second, but even in the holaspid period their vestiges are often discernible as linear dark shades in the test of perfectly preserved specimens. As early as at a late protaspid stage the occipital ring bears a small median tubercle which persists in all successive stages, except possibly in the largest specimens. The metacranidial spines appear at a late protaspid stage, persist through the earliest meraspid degrees but seem to atrophy abruptly in about Degree 4. The free cheeks are developed in a late protaspid stage. The genal spines are originally situated somewhat forwards and gradually migrate backwards to the postero-lateral angles of the cephalon. The anterior margin of the cephalon is straight in the protaspid and early meraspid stages and, in later stages, forms a gently curved line.

In early meraspid degrees the thoracic segments are quite different from those of the adult. In Degree 1, the free thoracic segment has very long and slender backwardly directed pleural spines, this being the case, too, in the foremost of the segments of the pygidium, whereas the succeeding segments terminate in rather short spines. The very prolonged pleural spines of the two foremost thoracic segments persist during the following stages. In Degree 14, probably earlier, the pleural spines of the first segment are of normal length, whereas those of the second segment are still prolonged, and, at least at a very early holaspid stage, when the dorsal shield has attained a length of about 13 mm, the spines of the second segment, too, are normal in length. In earlier meraspid stages, the pleural spines are almost perpendicular to the inner part of the pleuron, in later stages they become directed outwards-backwards and falcate in form as they do in the adult.

The »transitional» pygidium is well-developed at a late protaspid stage and has distinctly annulated axis and segmented lateral lobes with pleural spines. The number of segments varies in the meraspid degrees, seems to be four in Degree 15. From the transitional pygidium the segments were liberated, one by one, and incorporated with the thorax, until the holaspid period of development was attained.

At the protaspid and the earliest meraspid stages, the glabella displays a longitudinal furrow like that in *Hydrocephalus* BARRANDE. Different opinions have been advanced as regards the nature of this furrow. Barrande regarded it as primary and distinctive of *Hydrocephalus*. Raymond, who included *Hydrocephalus* in *Paradoxides*, also believed it to be primary, an opinion which was said to be supported by the fact that »one of the remarkable features of *Paradoxides harlani* is that this same longitudinal furrow of the glabella is present, at least as a line of weakness, in very large specimens» (Raymond, 1914, p. 230). Raw, on the contrary (1925, p. 268) believed it to be »purely secondary, being a natural result of compression in a flexible hemispherical or semi-ovoid test». The present material is not of a nature to definitely decide this question although Figs. 3 and 4 of Pl. IV especially, seem to speak in favour of the primary nature of the furrow being the more probable. It may also be remarked that, as far as the present writer is aware, a similar furrow has not been observed in the larvae of other genera.

Regarding the similarity of the occipital segment to the succeeding thoracic segment it might be expected that the metacranidial spines would issue from the former and correspond to the pleural spines of the latter, as seems to be the case, e. g., in *Hydrocephalus* and several other genera. In the present material of *Par. pinus*, however, the spines in question seem to extend from a point in front of the occipital segment, but do not appear to form the terminations of the palpebral lobes as claimed by Raymond (1914, pp. 230, 232) for *Hydrocephalus* and a protaspis of *Paradoxides* figured by him. Possibly they are formed by anchylosis of two pairs of originally separated spines belonging to the occipital segment and an anterior one.

The young of Paradoxides œlandicus. The youngest specimen found which may confidently be referred to *P. œlandicus* is a cranidium at a middle meraspid stage, 2.6 mm long and 3.1 mm broad (Pl. II, Fig. 1). It agrees with *P. pinus* of the same size, and, owing to the close resemblance of the adults of these two species, their developmental series may be expected to run, broadly speaking, parallel. The smallest complete specimen of *P. œlandicus* present (Pl. II, Fig. 4) — cephalon 6.6 and the whole shield 17.5 mm in length — has 16 thoracic segments, and as the number in all larger specimens is 17, it is regarded as a representative of the last meraspid degree. Otherwise it presents exclusively adult characteristics. In *P. œlandicus*, the holaspid period, consequently, seems to be attained when the dorsal shield has reached a length of about 18 mm, whereas in *P. pinus* the same period is even attained at no greater length than about 13 mm, which may indicate that the full-grown specimens of the former species were larger than those of the latter.

The young of Paradoxides sjögreni. Of the immature specimens found, only two, a 4.6 mm long cranidium and a 5.9 mm long cephalon, with the anterior thoracic segments attached (Pl. IX, Fig. 12), are referable to *P. sjögreni.* In the short eye and the rather pyriform glabella with the two anterior pairs of furrows distinctly marked, they agree with the adult of *P. sjögreni*, but differ in having a preglabellar area and a well-marked rim, the former a clear feature of immaturity, and the latter believed to be so too (cf. p. 42). In the thorax, too, as far it is preserved, the latter specimen agrees with *P. sjögreni,* excepting that the second segment has extremely prolonged pleural spines, a general characteristic of the young of *Paradoxides.* Consequently, there is strong evidence for including these specimens in *P. sjögreni.* It does not seem likely that they may belong to any of the forms described above as *Paradoxides* spp. Nos. 2 and 3 (which are very imperfectly known and possibly belong to but one species presumably nearly allied to *P. sjögreni*) as the latter fragments, in all probability, were collected from somewhat older layers. And one more closely related form, *Paradoxides* sp. No. 1, seems to be confined to much older strata and may therefore be left out of consideration in this connection.

Our knowledge of the ontogeny of *Paradoxides* may be said to be rather scanty as compared with that respecting certain other trilobites, and has hitherto been based mainly on Barrande's classical investigations into the Cambrian fauna of Bohemia. We have *Hydrocephalus* BARR. which, according to modern palaeontologists, is the young of *Paradoxides,* and some immature individuals of different species of this genus figured by Barrande, to which can be added a protaspis, figured by Raymond (1914), all from Bohemia, but only some cranidia of youthful forms seem to have been incidentally described and illustrated from Sweden, Great Britain, and America. Thus in regard to the degree of completeness of the development, *P. pinus* is more fully known than any other species of the genus.

The protaspis figured by Raymond (see text-fig. 10) is 1 mm long and, accordingly, somewhat larger than our Figs. 1 and 2 of Pl. IV. It compares very well with the latter although it is somewhat more advanced and may present a stage intermediate between our Figs. 2 and 3.

A cranidium at an early meraspid stage from the Œlandicus beds at Borgholm was figured and described by Linnarsson (1877) under the name of *P. aculeatus.* The specimen, which has been re-examined by the present writer, measures 1.4 mm in length and agrees perfectly with our Fig. 20 of Pl. IV. As it is associated with *Peronopsis fallax,* it doubtlessly originates from the zone of *Par. pinus,* and, with very great probability, may be presumed to be the young of that species.

As early as 1877, Linnarsson expressed the theory that *Hydrocephalus* from the Middle Cambrian of Bohemia was no distinct genus but embraced immature forms of *Paradoxides* and, consequently, should be included in the latter; Pompeckj (1895) agreed with this opinion but, as incontestable evidence proving their generic identity was said to be lacking, he continued to quote them as distinct genera. Beecher (1895) unhesitatingly included *Hydrocephalus* in *Paradoxides*, and in this he has been followed by modern palaeontologists, Raymond (1914) and Raw (1925), who have more closely studied the ontogeny of *Paradoxides*.

Raymond, who had at his disposal undescribed material too, from the Bohemian Paradoxides beds, pointed out that not only *Hydrocephalus* but also Barrande's species *Paradoxides pusillus* and *P. orphanus* as well as *P. inflatus* CORDA are based on immature specimens. He traced one line of development from *H. saturnoides* through *P. orphanus* and *P. pusillus* into *P. rugulosus* and another line form *H. carens* to *P. inflatus* which he with hesitation regarded as continuing into *P. bohemicus*, and he gives reasons for his opinions.

Fig. 10. Protaspis of *Paradoxides* sp. indet. Length about 1 mm. Teirovic, Bohemia. — After Raymond, 1914.

Broadly speaking, Raw accepted Raymond's views but opposed them in details. As Raymond was able to prove that all stages between and including the broad-brimmed *P. pusillus* and the narrow-brimmed *P. rugulosus* are present in the collection of the Museum of Comparative Zoology, these forms certainly belong to one developmental line. This line, however, according to Raw cannot be traced back to *H. saturnoides* which differs greatly from *P. pusillus*, especially in the shape of the thoracic segments, but, possibly, to a primitive larva of the same type as the protaspis figured by Raymond (see text-fig. 10). Raw agreed with Raymond that a *H. saturnoides* type developed into *P. orphanus* and as the latter (head-length 3.4 mm) compares fairly well with the smallest of Barrande's figures of *P. bohemicus* (head-length 4.7 mm) — the changes being small, in no case reversed, but in most cases being carried farther in later development — he concludes »that an ontogeny may be traced from *H. saturnoides* through *P. orphanus* to the adult *P. bohemicus*».

Raw traced a third developmental line claimed by Beecher and Raymond from *H. carens* (the broad form, the largest specimen of which has a 2 mm long cranidium), to *P. inflatus* (cephalic length 2.4 mm), and this line Raw traced farther to *P. spinosus*, stating that the earliest stage of the latter figured by Barrande (cephalic length 4.6 mm) has the same form of pleura, and that the only change of note was in the glabella (compare text-fig. 11) but that otherwise it was wholly in accordance with that seen in other lines of *Paradoxides*.

In the two latter lines, the important gaps are to be found between *H.*

saturnoides and *P. orphanus* and between *P. inflatus* (which as regards the glabella is of *Hydrocephalus* type) and *P. spinosus*, and it must be admitted that, until these gaps have been bridged over by finds of intermediate forms, the lines under consideration can scarcely be said to be proved with full certainty. However, granting that these developmental lines are correct, we find that the Bohemian species *P. bohemicus* and *P. spinosus*, both of them short-eyed forms, show ontogenies which resemble one another but which, in the glabella of early stages, are quite different from the Swedish long-eyed species *P. pinus*. The Hydrocephalus stages of the Bohemian species — embracing a row of degrees of the meraspid period characterized by a wide and enormously swollen, hemisperical glabella which occupies a large part of the cephalon and which at first is without evident segmentation — have, viz. no analogy in the line of the latter, the corresponding stages of which, on the

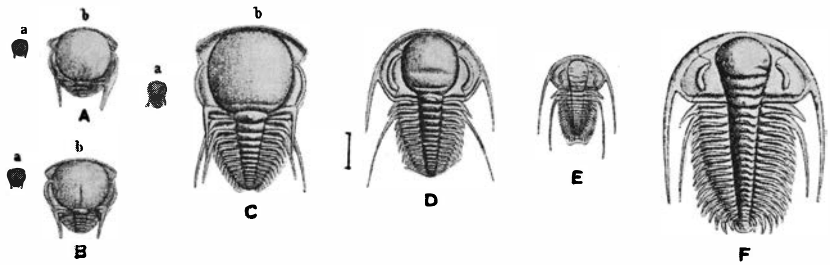


Fig. 11. Developmental series of *Paradoxides spinosus* (BOECK) according to Raw, 1925.

A—C, »*Hydrocephalus carens*» BARRANDE at three different meraspid stages. Complete specimens, except that the free cheeks are lacking. — D, »*Paradoxides inflatus*» BARRANDE. — E, specimen at a very early holaspid stage (18 thoracic segments); length 11 mm, spines not included. — F, young specimen, length 26 mm, having the pleural spines of the first and second thoracic segments longer than full-grown specimens. — After Barrande, 1852.

contrary, have a narrow and distinctly lobed glabella. In this feature the larval forms of *P. pinus* are primitive when compared with *Hydrocephalus* which, as claimed by Raymond and Raw, is specialized.

In addition to the differences in width and segmentation of the glabella, there also exists a striking difference in its length. In the line *H. carens* — *P. inflatus* — *P. spinosus* (short-eyed) all known stages have a long glabella which extends to the marginal rim, as is the case in all adult forms of *Paradoxides*. In the line *H. saturnoides* — *P. orphanus* — *P. bohemicus* (short-eyed) the glabella in the earliest stages touches the rim but, in later meraspid stages (compare also Pompeckj, 1895, p. 530, Pl. 16, Fig. 4), is separated from it by a narrow preglabellar area which, however, in still later meraspid stages has disappeared. In the line *P. pusillus* — *P. rugulosus* (long-eyed) the area is broad in the »pusillus stage». In the protaspid and earliest meraspid stages of *P. pinus* (long-eyed) the glabella reaches to the narrow marginal rim, afterwards becomes separated from it by a fairly broad area which, later on diminishes and in the early holaspid stages is wholly lost. Other long-eyed species, too, of which youthful forms are known, e. g. the Canadian species

P. eteminicus MATTH. and *P. acadicus* MATTH. (Matthew, 1882, pp. 93—107, Pl. 9), are characterized by a broad preglabellar area which, in later stages, disappears. As pointed out by Raw it cannot, however, be claimed that only the ontogenies of long-eyed forms of *Paradoxides* show broad-brimmed immature forms, as such forms are found in the ontogenies of several short-eyed species

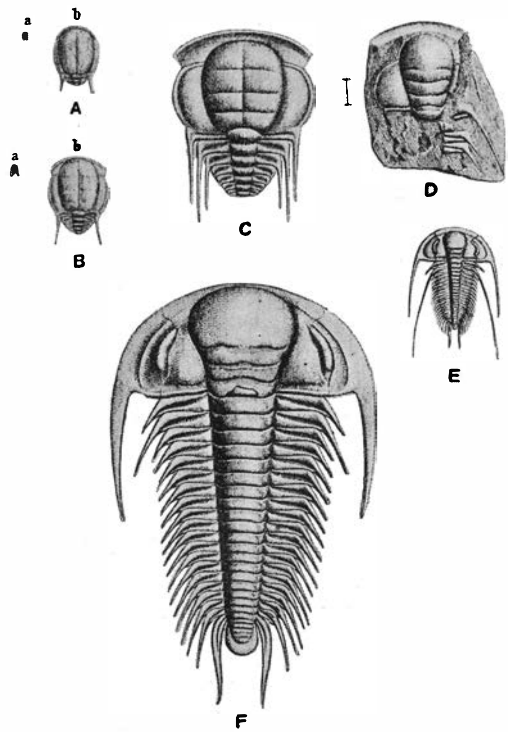


Fig. 12. Developmental series of *Paradoxides bohemicus* (BOECK) according to Raw, 1925.

A—C, »*Hydrocephalus saturnoides*» BARRANDE at three different meraspid stages. Complete specimens, except that the free cheeks are lacking. Length of C 1.5 mm. — D, »*Paradoxides orphanus*» BARRANDE. — E, specimen at a very early holaspid stage (20 thoracic segments), with the pleural spines of the second segment greatly prolonged. Length 13 mm, spines not included. — F, young specimen with all pleural spines of normal length. Lenght 48 mm, spines not included. — After Barrande, 1852.

too — in addition to the above-mentioned *P. bohemicus* in which this feature is less conspicuous — e. g., in *P. sjögreni*, *P. hicksi* SALTER, *P. jemtlandicus* WIMAN, and *P. tessini* BRONGN.

Protaspid forms developing into *Hydrocephalus* are still unknown. The protaspis of *P. pinus*, as well as the one figured by Raymond, compares fairly well with the protaspis of several Middle Cambrian species, e. g., *Sao hirsuta* BARR., *Liostracus linnarssoni* BRÖGGER (Warburg, 1925, p. 25), and the Upper Cambrian *Olenus gibbosus* (WAHL.) (Strand, 1927). In one feature, *Paradoxides* is sharply distinct from the latter genera, however. Even in the earliest protaspis of *Paradoxides*, the glabella is bounded by axial furrows which meet in front of it, whereas in the protaspis of all the latter genera mentioned, the frontal lobe projects into a swollen, outwards and backwards tapering »larval ridge» (Warburg, 1925). In this feature, *Paradoxides* is more advanced and approaches, e. g., the Upper Cambrian *Peltura scarabaeoides* (WAHL.) (Poulsen, 1923, p. 58).

Family **Ellipsocephalidae** MATTHEW.

Genus **Ellipsocephalus** ZENKER, 1833.

Ellipsocephalus polytomus LINNARSSON, 1877. Pl. XI, Figs. 5—17.

Ellipsocephalus hoffi (pars), Sjögren, 1872, p. 75. (The forms of *Ellipsocephalus* from the Œlandicus and Tessini beds of Öland are identified as *E. hoffi* (SCHLOTH.) although the number of thoracic segments is said to be more than 12 (13 or 14).

Ellipsocephalus sp. indet., Sjögren, 1872, p. 75. (Cranidia of large specimens; no figure.)

Ellipsocephalus polytomus, Linnarsson, 1877, p. 12 (363), Pl. 2 (15), Fig. 1. (Characterizes the form from the Œlandicus shale at Borgholm as a distinct species; a complete specimen figured.)

Ellipsocephalus polytomus, Kiaer, 1916, pp. 48, 50; text-fig. 6 d. (Discusses the affinities of this and kindred forms; figures two thoracic segments.)

Ellipsocephalus polytomus, Hedström, 1923, p. 14, Pl. 2, Figs. 5, 7. (Figures two imperfect cranidia from the Œlandicus shale of a boring at Visby, Gotland.)

Strenuella subgotlandica, Hedström, 1923, p. 14, Pl. 2, Figs. 6 a—c. (A somewhat flattened and crushed and, consequently, slightly disfigured cranidium described and figured.)

Anomocare balticum, Hedström, 1923, p. 13, Pl. 2, Fig. 4. (A cranidium of a specimen at a late meraspid stage, described and figured.)

»Free cheeks of trilobites», Hedström, 1923, p. 15, Pl. 2, Figs. 8, 9. (Figures two free cheeks, the one of a young specimen provided with a short spine, the other of a somewhat older specimen showing the spine almost obliterated.)

Remarks. The anterior branch of the facial suture runs forwards from the eye in a gently curved line to the antero-lateral margin and then, in the very margin, to the middle line where it meets the opposite branch. The truncate termination of the doublure in Fig. 15 is undoubtedly formed by a rupture. — As a rule, the occipital furrow is fairly distinct in internal casts, even of large specimens. — Hypostoma unknown.

More than twenty complete specimens, varying in length between 12.5 and 35 mm, have fourteen thoracic segments. One specimen, 13.5 mm long, shows only thirteen segments which, in this case, seems to be the actual number since no evidence indicates that the first segment might have been concealed at the embedding. Otherwise, this specimen does not present any immature characteristics.

The average size of the specimens found in the upper zone is somewhat less than that of the specimens from the lower zone, from the upper part of the latter at least. This difference was noticed by Sjögren, and as the larger specimens of his collection (preserved in limestone and originating from a locality, Stora Frö, where the upper zone does not crop out) showed a delicately punctate test whereas the smaller specimens (preserved in shale and collected, some of them at least, from younger strata at Borgholm) presented a smooth and dense test he concluded that the large specimens might possibly belong to a distinct species. Linnarsson assumed that this difference in sculpture was probably apparent and owing merely to the different modes of preservation, an opinion which seems to be correct. Thus, irrespective of level and finding place, all the specimens present preserved in limestone, show punctate test, whereas this subtile sculpture is indiscernible, or at least very indistinct, in the specimens in shale.

D i m e n s i o n s. A complete specimen of average size (Fig. 11) is 30 mm long (cephalon 11.5, thorax 17, pygidium 1.5), 18 mm broad across the cephalon and 16.5 mm across the anterior part of the thorax. The largest isolated cranidium present is 23 mm long, indicating a total length of about 60 mm.

E n r o l l m e n t. It is a well-known fact that enrolled specimens of multisegmentate Cambrian trilobites are found rarely, but they are by no means wanting as claimed by some authors. It is enough to recall Barrande's (1852, 1872) descriptions and illustrations of completely rolled-up specimens of *Arionellus ceticephalus*, *Conocephalites sulzeri*, *Sao hirsuta*, and *Ellipsocephalus hoffi*.

In the Œlandicus beds of Öland, entirely enrolled specimens of *E. polytomus* and *Solenopleura cristata* have been found, and Linnarsson (1877, p. 368) also mentions a rolled-up specimen of *Bailiella emarginata;* ten examples of *E. polytomus* and two of *S. cristata* are present. All these specimens show what Barrande called *enroulement double*, i. e., one of the posterior thoracic segments — in the case of *E. polytomus* the ninth or tenth — is closely applied to the doublure of the cephalon, the subsequent segments and the pygidium being concealed between the cephalon and the thorax. And specimens of *E. polytomus* in the first stage of double enrollment, with the pygidium and the posterior two to six thoracic segments turned under the visible part of the thorax, are not at all rare.

O n t o g e n y. The youngest specimen found is a cranidium 2.4 mm in length (Pl. XI, Fig. 5). It has a narrow, convex marginal rim and distinct ocular ridges and palpebral lobes; the first pair of glabellar furrows are indiscernible and the three posterior pairs very faintly marked as short and weak impressions on the sides of the glabella; the occipital furrow is strongly marked throughout. — A complete specimen, Fig. 6, at a somewhat later stage of growth, is about 6 mm long (cephalon 2.7, thorax 3, pygidium — two coalesced segments inclusive — 0.26). The cranidium shows the same immature characters as the preceding specimen, and the free cheek has a long spine. The thorax has 11 free segments; in the second segment the pleura are prolonged into long spines, in the remainder, the pleura end in short, deflected, sharply pointed spines. Two segments are still grown together with one another and with the terminal plate that corresponds to the pygidium of the adult. — A cranidium 2.8 mm in length, Fig. 7, is somewhat more advanced, having the marginal rim almost obliterated in front of the glabella. — A complete specimen, Fig. 8, which is about 12.5 mm long (cephalon 4.9, thorax 7, pygidium 0.6) has short genal spines that project rather abruptly from the curved margin and, in all thoracic segments, short, deflected, pleural spines, but otherwise it shows adult characteristics, even as regards the number of thoracic segments. In specimens at later stages, the genal and pleural spines become gradually reduced and, finally, entirely obliterated.

At the early stages of growth, *Ellipsocephalus*, in the cranidium, resembles *Anomocare* which may corroborate Kiaer's (1916, p. 53) opinion that these two genera have developed from the same original stock. The similarity has induced Hedström (1923) to describe a cranidium of *E. polytomus*, 2.4 mm long and at the stage of our Fig. 5, as a species of *Anomocare*.

Horizon and locality. *E. polytomus* appears early in the Œlandicus beds of Öland, persists through these beds and ascends into the basal layer of the Tessini beds, viz., the conglomerate of *Acrothele granulata;* however, in the latter it appears possibly secondarily, i. e., redeposited from older strata which were eroded before consolidation. It is one of the most common species in the Œlandicus beds, and in the core from Mossberga it was found to be rather abundant in a thin layer at a level of 9 m. It is found in the Œlandicus beds of Östergötland, Närke, Jämtland and Gotland (deep-boring) too, i. e., in all areas of Sweden from which these beds are known except that of Ångermanland—Lapland. *E. polytomus* does not seem to occur in the corresponding strata of Norway.

Family **Conocoryphidae** ANGELIN.

Genus **Bailiella** MATTHEW, 1885.

Bailiella emarginata (LINNARSSON, 1877). Pl. XI, Figs. 1—3.

Conocoryphe Dalmanni?, Sjögren, 1872, p. 75. (Cranidium briefly characterized; no figure; Stora Frö, Öland.)

Conocoryphe emarginata, Linnarsson, 1877, p. 366 (15), Pl. 15 (2), Figs. 2—4. (Description and figures of cranidium and part of thorax with attached pygidium; Stora Frö, Öland.)

Description. Dorsal shield ovate, convex.

Cephalon, the genal spines neglected, semicircular; marginal rim approximately equal in breadth throughout, slightly widened in front of the glabella; marginal furrow rather shallow, does not curve backwards at the axial line; axial furrows moderately deep and narrow. Glabella occupies somewhat more than one-third of the breadth of the cranidium, conical, moderately rounded in front, separated from the rim by a flat preglabellar field of about the same breadth as the rim. Glabellar furrows rather weak, the two posterior pairs oblique, the two anterior pairs short and transverse; the foremost pair often indiscernible. Occipital furrow narrow, shallow at the axial line, deep at the sides. Occipital ring somewhat expanded at the middle, with a small and blunt median tubercle. Fixed cheeks display, near the anterior corners of the glabella, a pair of short and oblique ridges; in internal casts the ridges are elongated, and on the space between them and the marginal rim a network of anastomosing, extremely faint ridges is usually visible. Free cheeks very narrow, inconsiderably broader than the marginal rim. Genal angles prolonged into spines which terminate on a level with the fourth thoracic segment. Marginal (rostral) suture is posteriorly supra-marginal, cuts the posterior margin immediately within the genal spine, continues forwards and slightly inwards in a gently curved line immediately within the lateral marginal furrow, traverses the antero-lateral border very obliquely and seems to become quite marginal in front of the glabella.

Thorax of 15 segments. Axis strongly arched, occupies about one-fourth of the total width (in projection). Pleura strongly geniculated, rise gently from the axial furrow to the fulcrum, then dip abruptly downwards; fulcrum halfway from the axial furrow in the anterior and middle segments, approximated to the axial furrow in the posterior segments; pleural furrows deep and narrow, continue almost to the blunt ends of the pleura.

Pygidium small, twice as broad as long. Axis conical and blunt, occupies more than one-third of the total width, has two rings in addition to the end-lobe, reaches almost to the margin. Lateral lobes with two pairs of distinct furrows and a third pair indicated; marginal rim absent.

Test thick, granulated, with closely-set, fine grains approximately equal in size.

Dimensions. A complete specimen somewhat below middle-size (Fig. 1) is 32 mm long (cephalon 11.5, thorax 18, pygidium 2.5) and 18 mm broad across the thorax. The largest cranidia measure about 20 mm in length.

Remarks and Affinities. Linnarsson (1877, p. 368) mentions an enrolled specimen of this species.

B. emarginata presents a close resemblance to *B. tenuicincta* (LINNARSSON), of the zone of *Ctenocephalus exsulans*. In the cranidium — the only part of *B. tenuicincta* which is known — the latter differs from the former mainly in having somewhat narrower glabella and by the granulation showing scattered large grains besides the small ones.

A probably allied form, *B. emarginata longifrons*, has been described by Cobbold (1911, 1934) from the *Paradoxides groomi* fauna of Shropshire, England. It is distinguished from the Swedish form by a more quadrate outline of the cranidium, a narrower subcylindrical glabella, and markedly weaker glabellar furrows.

Horizon and locality. Zone of *Par. insularis*. Öland: Mossberga; Stora Frö, parish of Vickleby; Mörbylånga (boulders). — Rather infrequent.

Family **Solenopleuridae** ANGELIN.

Genus **Solenopleura** ANGELIN, 1854.

Solenopleura cristata LINNARSSON, 1877. Pl. XII, Figs. 1—7.

Selenopleura cristata, Linnarsson, 1877, p. 19, (370), Pl. 2 (15), Figs. 5 a—b, 6. (Description of cephalon and thoracic segments and figures of cephalon from Borgholm, Öland.)

Description. Dorsal shield ovate, strongly convex; the breadth about three-fifths the length.

Cephalon semicircular; genal angles rounded but have, in some specimens, a very weak point springing abruptly from the margin and giving the curve a slightly angular course. Marginal rim broad, strongly upturned in front of the glabella; marginal furrow shallow. Glabella bounded by deep axial furrows which do not join the marginal furrow (as claimed by Linnarsson), separated from the rim by a very narrow flat or even concave preglabellar area. Glabellar furrows faint; usually two, sometimes three pairs are visible, and, rarely, a fourth (anterior) pair are indicated as very short linear interruptions in the sculpture of the test. Occipital ring with a small median tubercle. Fixed cheeks greatly inflated but do not attain the height of the glabella. Ocular ridge faint or obsolete. Anterior branch of the facial suture runs from the eye forwards and slightly outwards to the antero-lateral marginal furrow, traverses the rim obliquely and then becomes exactly marginal.[1]

Thorax of fourteen segments. Axis strongly arched, with a row of highly projecting coarse and blunt points which are lacking in the two hindmost segments. Pleura horizontal or rising slightly to the fulcrum, then bent down abruptly almost at right angles; fulcrum half-way from the axial furrows in the anterior segments, approximated to the axial furrows in the middle and, still more so, in the posterior segments; terminations of the pleura obtuse.

Pygidium small, two and a half times as broad as long. Axis occupies about one-third the total width, slightly conical, terminating obtusely just within the margin, has one ring besides the terminal portion. Lateral lobes showing two pairs of furrows; no distinct marginal rim.

Test finely granulated in prominent parts, otherwise smooth.

E n r o l l m e n t. Two specimens present are double enrolled, with the ultimate or penultimate thoracic segment closely applied to the doublure of the cephalon (see also p. 57).

D i m e n s i o n s. A complete specimen of middle size and in full relief (Fig. 3) is 26.2 mm long (cephalon 9.6, thorax 14.8, pygidium 1.8) and 15.5 mm broad across the thorax. The largest complete specimen present, in shale, is about 40 mm long and 24 mm broad.

A f f i n i t i e s. *S. cristata* agrees with the genotype, *S. holometopa* (ANG.), in all essential characteristics and is certainly a true *Solenopleura*. It is the oldest species of the genus in Scandinavia. It is rather closely allied to the somewhat younger form, *S. parva* LINNARSSON, of the zone of *Ctenocephalus exsulans*, which is distinct from it mainly in having the genal angle produced into a small, broad but very short, spine, the outer border of which is almost continuous with the outer border of the cheek, the narrow preglabellar area convex, (and, possibly, a larger pygidium with four rings in the axis and four pairs of furrows in the lateral lobes).

A form from the Œlandicus beds of the Mjösen area of Norway which, by Strand (1929, p. 353) was identified as *S. cristata*, has markedly narrower glabella and may probably be a distinct species or variety.

H o r i z o n a n d l o c a l i t y. In Öland confined to the zone of *Par. insularis*. Öland: SW of Alböke; Borgholm; Strandtorp, parish of Räpplinge; Ekerum and Mossberga, parish of Högsrum; Mörbylånga (boulders). — Östergötland: Vågforsen, NE of Skänninge (teste S. Rosén). — (?) Jämtland: Bingsta. — Rather common in Öland.

[1] Whether the truncate termination of the doublure seen in Fig. 7 is formed by a suture or a rupture cannot be decided with certainty.

Phyllocarida.

Family **Hymenocaridae** SALTER.

Genus **Hymenocaris** SALTER (1853) 1866.

Hymenocaris (?) *œlandica* HOLM MS. Pl. XII, Figs. 10—12.

D e s c r i p t i o n: Carapace probably forms a univalve. On side view the outline is sub-rotund with the exception of the nearly straight dorsal margin. Antero-dorsal angle about 90°, posterior angle rounded. A marginal rim (which seems to correspond to a doublure) is indicated on the anterior and ventral sides and is somewhat widened and smoothed out on the posterior side A small and short ridge-like swelling (probably primary) occurs at the antero-dorsal end; otherwise no irregularities of the surface seem to exist. Test thin, black, corneous, smooth, and brittle.

No s a f e traces of abdominal segments have been observed.

The largest specimen, Fig. 12, is 11 mm long and 7.5 mm high.

R e m a r k s. A few specimens are present which were labelled by G. Holm »*Hymenocaris œlandica* n. sp.». Owing to the imperfect state of preservation the generic reference is doubtful, however. All specimens are crushed and show the carapace from side view.

This species compares fairly well with *H. obliqua* WALCOTT from the Middle Cambrian Burgess shale of British Columbia (Walcott, 1912 a, p. 185). In several features it also resembles certain Cambrian conchostraca, e. g. *Aluta rotundata* (WALCOTT) (Ulrich & Bassler, 1931, p. 60) but, as mentioned above, the material at hand does not speak in favour of the carapace being bivalved.

H o r i z o n a n d l o c a l i t y. Zones of *Par. insularis* and *Par. pinus*. Öland: Borgholm; Strandtorp, 5 km SSW of Borgholm; Mossberga; Kleva, 4 km NNE of Mörbylånga. — Rare.

Geographical and Stratigraphical Distribution of the Fauna Elements.

		Micromitra (Iphidella) ornatella princeps n. var.	*Lingulella ferruginea* SALTER	*Lingulella* (?) sp.	*Acrothele (Redlichella) granulata* (LINNARSSON)	*Acrotreta schmalenseei* WALCOTT	» *socialis* v. SEEBACH	Orthoid brachiopod	*Ölandia pauciplicata* n. gen. et n. sp.	*Orthotheca corneola* HOLM	» *teretiuscula* (LINNARSSON)	» *affinis* HOLM	*Hyolithes ölandicus* HOLM	» *obesus* HOLM	» *socialis* LINNARSSON
Mjösen area, Norway			+		+	+									
Jämtland		+			+	+					+				
Närke		+			+										
Östergötland		+	+		+	+									
Mörbylånga	Boulders	+	+		+	+					+	+			+
Mörbylånga	W of Risinge				+										
Mörbylånga	1 km SSW of the church												+		
Well-sinking at Kleva, 4 km NE of Mörbylånga			+		+								+		
Stora Frö, 7 km NNE of Mörbylånga			+	+	+				+		+			+	
Högsrum, Mossberga boring core	Portion above 10.8 m	+	+		+	+						+	+		
Högsrum, Mossberga boring core	Portion beneath 10.8 m		+	+	+	+	?						+	+	
Högsrum	Ekerum		+		+	+	+				+				
Strandtorp, 5 km SSW of Borgholm					+	+					+				
Borgholm	Other localities and boulders		+		+	+	+	+			+		+		
Borgholm	Well-sinking in 1889, 3.5 m deep	+	+		+		+		+	+		+	+	+	
4 km SW of Alböke		+	+		+										
Northern point of Öland (boulders)					+										
Zone of *Par. pinus*		+	+		+	+	+		+	+	?	+	+	+	?
Zone of *Par. insularis*		+	+	+	+	+	+	+	+		+		+	+	

Condylopyge regia (SJÖGREN)	+					+			+		+							+	
» *carinata* n. sp.		+			+					+									
Peronopsis integra (BEYRICH)	?										?								
» *fallax* (LINNARSSON)		+			+	+				+		+		+				+	
Agnostus gibbus praecurrens n. var.		+			+	+				+			+					+	?
Calodiscus œlandicus n. sp.		+								+			+						
Burlingia laevis WESTERGÅRD		+			+					+									
Paradoxides œlandicus SJÖGREN	+	+	?	?	+	+	?	+	+	+	+				+	?	?	+	+
» *quadrimucronatus* HOLM MS.	+	+			+	+			+	+									
» *bidentatus* n. sp.	?	+			+	+							+				+	+	
» *pinus* HOLM MS.		+			+	+				+		+	+	+				+	?
» *insularis* n. sp.	+			+		+	+	+	+										
» *torelli* HOLM MS.		+			+	+				+			+					+	+
» *sjögreni* LINNARSSON	+	+	+		+	+		+	+	?	+				+				
» sp. No. 1 (*P. groomi* LAPWORTH?)	+							(+)	+										
» sp. No. 2		+				+													
» sp. No. 3		+				+													
» sp. No. 4		?				+													
Ellipsocephalus polytomus LINNARSSON	+	+	+	+	+	+		+	+	+	+	+	+		+	+	+	+	
Bailiella emarginata (LINNARSSON)	+								+		+				+				
Solenopleura cristata LINNARSSON	+			+		+	+	+	+						+	+		?	?
Hymenocaris (?) *œlandica* HOLM MS.	+	+			+		+		+			+							

Bibliography.

Angelin, N. P. 1851—1854. Palaeontologia Scandinavica. P. 1. — Holmiae. In 4:o. Index to N. P. Angelin's Palaeontologia Scandinavica, with Notes by A. H. Westergård. — Lunds Univ. Årsskr., N. F., Afd. 2, Bd 6, No. 2 (= Fysiogr. Sällsk. Handl., N. F., Bd 21, No. 2). Lund 1910.

Asklund, B. & Thorslund, P. 1935. Fjällkejderandens bergbyggnad i norra Jämtland och Ångermanland. — Sver. Geol. Unders., Ser. C, No. 382.

Barrande, J. 1852. Système Silurien du Centre de la Bohême. Vol. 1. — Prague.

—, 1872. Système Silurien du Centre de la Bohême. Supplément au Vol. 1. — Prague.

Beecher, C. E. 1895. The Larval Stages of Trilobites. — American Geologist, Vol. 16, pp. 166—197, pls. 8—10.

Brögger, W. C. 1878. Om paradoxidesskifrene ved Krekling. — Nyt Mag. for Naturvid., Vol. 24, pp. 18—88, pls. 1—6.

—, 1882. Paradoxides Ölandicus-nivået ved Ringsaker i Norge. — Geol. För. Förh., Bd 6 (1882—1883), pp. 143—148.

Cobbold, E. S. 1911. Tribolites from the Paradoxides Beds of Comley (Shropshire). — Quart. Journ. Geol. Soc., Vol. 67, pp. 282—311, pls. 23—26.

—, 1934. The Cambrian Genus Stenotheca. — Geol. Mag., Vol. 71, pp. 463—468, pl. 23.

— & Pocock, R. W. 1934. The Cambrian Area of Rushton (Shropshire). — Phil. Trans. Roy. Soc. London, Ser. B, Vol. 223, pp. 305—409, pls. 38—45.

Dames, W. 1881. Geologische Reisenotizen aus Schweden. — Zeitschr. Deutsch. geolog. Gesellsch., Jahrg. 1881, Bd 33, pp. 405—441.

Grabau, A. W. & Shimer, H. W. 1909—1910. North American Index Fossils. — New York.

Grönwall, K. A. 1902. Bornholms Paradoxideslag. — Danmarks geol. Unders. II. Række. Nr. 13.

Hedström, H. 1923. Remarks on some Fossils from the Diamond Boring at the Visby Cement Factory. — Sver. Geol. Unders., Ser. C, No. 314.

— & Wiman, C. 1906. Beskrifning till Blad 5. — Sver. Geol. Unders., Ser. A, a.

Henriksen, K. L. 1926. The Segmentation of the Trilobite's Head. — Medd. fra Dansk geol. Foren., Vol. 7 (1926—1930), pp. 1—32.

Hicks, see Salter.

Holm, G. 1893. Sveriges kambrisk-siluriska Hyolithidae och Conularidae. — Sver. Geol. Unders., Ser. C, No. 112. In 4:o.

Howell, B. F. 1935 a. New Middle Cambrian Agnostian Trilobites from Vermont. — Journ. of Paleont., Vol. 9, pp. 218—221, pl. 22.

—, 1935 b. Cambrian and Ordovician Trilobites from Hérault. Southern France. — Ibid., Vol. 9, pp. 222—238, pls. 22—23.

—, 1935 c. Some New Brunswick Cambrian Agnostians. — Bull. Wagner Free Inst. Sci., Vol. 10, No. 2, pp. 13—15, pl.

Illing, V. C. 1916. The Paradoxidian Fauna of a Part of the Stockingford Shales. — Quart. Journ. Geol. Soc., Vol. 71, pp. 386—450, pls. 28—38.
Jaekel, O. 1909. Über die Agnostiden. — Zeitschr. Deutsch. Geol. Ges., Bd. 61, pp. 380—401.
Kiaer, J. 1916. The Lower Cambrian Holmia Fauna at Tömten in Norway. — Videnskapsselsk. Skrifter. I. Mat.-Naturv. Klasse, 1916. No. 10.
Lake, Ph. 1907, 1935. British Cambrian Trilobites. Pts. II, IX. — Palaeont. Soc., 1907, 1934.
Linnarsson, G. 1869. Om Vestergötlands cambriska och siluriska aflagringar. — Vet.-Ak. Handl., Bd 8, No. 2.
—, 1876 a. On the Brachiopoda of the Paradoxides Beds of Sweden. — Vet.-Ak. Bih., Bd 3. No. 12.
—, 1876 b. Geologiska iakttagelser under en resa på Öland. — Geol. För. Förh., Bd 3, pp. 71—86.
—, 1877. Om faunan i lagren med *Paradoxides œlandicus.* — Geol. För. Förh., Bd 3, pp. 352—375, pls. 14—15. — Also as Sv. Geol. Unders., Ser. C, No. 22.
—, 1879. Om faunan i kalken med *Conocoryphe exsulans.* — Sver. Geol. Unders., Ser. C, No. 35.
Matthew, G. F. 1882. Illustrations of the Fauna of the St. John Group. No. 1. The Paradoxides. — Trans. Roy. Soc. Canada, Sect. 4, pp. 87—108, pl. 9.
—, 1885. Illustrations of the Fauna of the St. John Group continued: on the Conocoryphea, with further remarks on Paradoxides. — Ibid. Vol. 2 (1884), Sect. 4, pp. 99—124, pl. 1.
—, 1887. Illustrations of the Fauna of the St. John Group. No. 4. Pt. 1, *Paradoxides regina.* Pt. 2, The Small Trilobites with eyes. — Ibid. Vol. 5, Sect. 4, pp. 115—166, pls. 1—3.
—, 1896. Faunas of the Paradoxides Beds in Eastern North America. No. 1. — Transact. N. Y. Acad. Sci., Vol. 15, pp. 192—247, pls. 14—17.
Munthe, H. 1902. Beskrifning till kartbladet Kalmar. — Sver. Geol. Unders., Ser. Ac, No. 6.
— & Hedström, H. 1904. Beskrifning till kartbladet Mönsterås med Högby. — Ibid., Ser. Ac, No. 8.
Nathorst, A. G. 1882. Om det inbördes åldersförhållandet mellan zonerna med *Olenellus Kjerulfi* och *Paradoxides œlandicus.* — Geol. För. Förh., Bd 6, pp. 27—30.
Pompeckj, J. F. 1895. Die Fauna des Cambrium von Tejřovic und Skrej in Böhmen. — Jahrb. k. k. geol. Reichsanstalt, Bd. 45, pp. 495—614, pls. 13—17.
Poulsen, Chr. 1923. Bornholms Olenuslag og deres Fauna. — Danm. Geol. Unders., II. Række, No. 40.
—, 1927. The Cambrian, Ozarkian, and Canadian Faunas of Northwest Greenland. — Medd. om Grönland, Vol. 70, pp. 233—343, pls. 14—21.
Raw, Frank. 1925. The Development of *Leptoplastus salteri* and other Trilobites. — Quart. Journ. Geol. Soc., Vol. 81, pp. 223—324, pls. 15—18.
—, 1927. The Ontogenies of Trilobites, and their Significance. — Amer. Journ. Sci., Vol. 14, pp. 7—35, 131—149, 240.
Raymond, P. E. 1914. Notes on the Ontogeny of Paradoxides, with the Description of a New Species from Braintree, Mass. — Bull. Museum Compar. Zoology, Vol. 58, pp. 225—244.
Salter, J. W & Hicks, H. 1867. On a New *Lingulella* from the Red Lower Cambrian Rocks of St. Davids. — Quart. Journ. Geol. Soc., Vol. 23, pp. 339—341.
—, 1869. On some Fossils from the »Menevian Group». — Quart. Journ. Geol. Soc., Vol. 25, pp. 51—57, Pls. 2—3.

v. Seebach, K. 1865. Beiträge zur Geologie der Insel Bornholm. — Zeitschr. Deutsch. Geol. Ges., Bd 17, pp. 338—347, pl. 8 a.

Sjögren, A. 1852. Anteckningar om Öland, ett bidrag till Sveriges geologi. — Vet. Ak. Öfvers., Årg. 8 (1851), pp. 36—42.

—, 1871. Bidrag till Ölands geologi. — Vet. Ak. Öfvers., Årg. 28, pp. 673—681.

—, 1872. Om några försteningar i Ölands Kambriska lager. — Geol. För. Förh., Bd 1 (1872—1873), pp. 67—80, pl. 5.

Strand, T. 1927. The Ontogeny of *Olenus gibbosus*. — Norsk Geol. Tidsskr., Bd 9 (1926—1927), pp. 320—330, pl. 2.

—, 1929. The Cambrian Beds of the Mjösen District in Norway. — Norsk Geol. Tidsskr., Bd 10 (1928—1929), pp. 308—366, pls. 1—2.

Thorslund, see Asklund.

Tullberg, S. A. 1880. Om Agnostus-arterna i de kambriska aflagringarna vid Andrarum. — Sver. Geol. Unders., Ser. C, No. 42. In 4:o.

Ulrich, E. O. & Bassler, R. S. 1931. Cambrian Bivalved Crustacea of the Order Conchostraca. — Proc. U. S. Nat. Mus., Vol. 78, Art. 4.

Walcott, C. D. 1884. On the Cambrian Faunas of North America. — Bull. U. S. Geol. Surv., No. 10.

—, 1908. Cambrian Geology and Paleontology. Vol. 1, No. 2, Cambrian Trilobites. — Smiths. Misc. Coll., Vol. 53.

—, 1910. Cambrian Geology and Paleontology, Vol. 1, No. 6, Olenellus and other Genera of the Mesonacidae. — Ibid., Vol. 53, No. 6.

—, 1912 a. Cambrian Geology and Paleontology. Vol. 2, No. 6, Middle Cambrian Branchiopoda, Malacostraca, Trilobita, and Merostomata. — Ibid., Vol. 57, No. 6.

—, 1912 b. Cambrian Brachiopoda. — Monogr. U. S. Geol. Surv., Vol. 51.

Warburg, Elsa. 1925. The Trilobites of the Leptaena Limestone in Dalarne. — Bull. Geol. Inst. Upsala, Vol. 17.

Westergård, A. H. 1929. A Deep Boring through Middle and Lower Cambrian Strata at Borgholm, Isle of Öland. — Sver. Geol. Unders., Ser. C, No. 355.

—, 1931. Diplocraterion, Monocraterion, and Scolithus from the Lower Cambrian of Sweden. — Sver. Geol. Unders., Ser. C, No. 372.

Wiman, see Hedström.

Explanations of Plates.

If nothing is mentioned as regards the rock, the specimen is preserved in shale.
If no other statement is made, the specimen belongs to the Geological Survey.

Plate I.

Condylopyge regia (SJÖGREN). Page 27.

Fig. 1 a, b. Dorsal and side view of complete specimen, in limestone. Stora Frö, 7 km NNE of Mörbylånga.
» 2. Cephalon. Mossberga; level 15.8 m.
» 3 a, b. Dorsal and side view of pygidium. Mossberga; level 19.4 m.

Condylopyge carinata n. sp. Page 27.

» 4. Complete specimen. Borgholm, well-sinking in 1889.
» 5. » » » » » » » —Holotype.
» 6 a, b. Dorsal and side view of cephalon. Mossberga; level 9.6 m.
» 7 a, b. » » » » » pygidium. » » » »
» 8 a, b. » » » » » » » » 8.9 »

Peronopsis fallax (LINNARSSON). Page 28.

» 9. Complete specimen. Borgholm; well-sinking in 1889.
» 10. Cephalon, with the anterior thoracic segment displaced. Mossberga; level 6.3 m.
» 11. Pygidium. Mossberga; level 6.3 m.
» 12. » » » 7.9 »
» 13. Pygidium showing three pairs of scars indicating segmentation of the axis. Mossberga; level 10.0 m.
» 14. Pygidium of a very young specimen, with the posterior thoracic segment, laterally at least, still anchylosed with the pygidium. Length 0.75 mm, breadth 0.77 mm. Mossberga, level 7.2 m.
» 15. Complete specimen; total length 2.1 mm (cephalon 0.97, pygidium 0.86). Slightly more advanced than Fig. 14, with the posterior thoracic segment quite free. Mossberga; level 6.3 m.

Peronopsis integra (BEYRICH). Page 28.

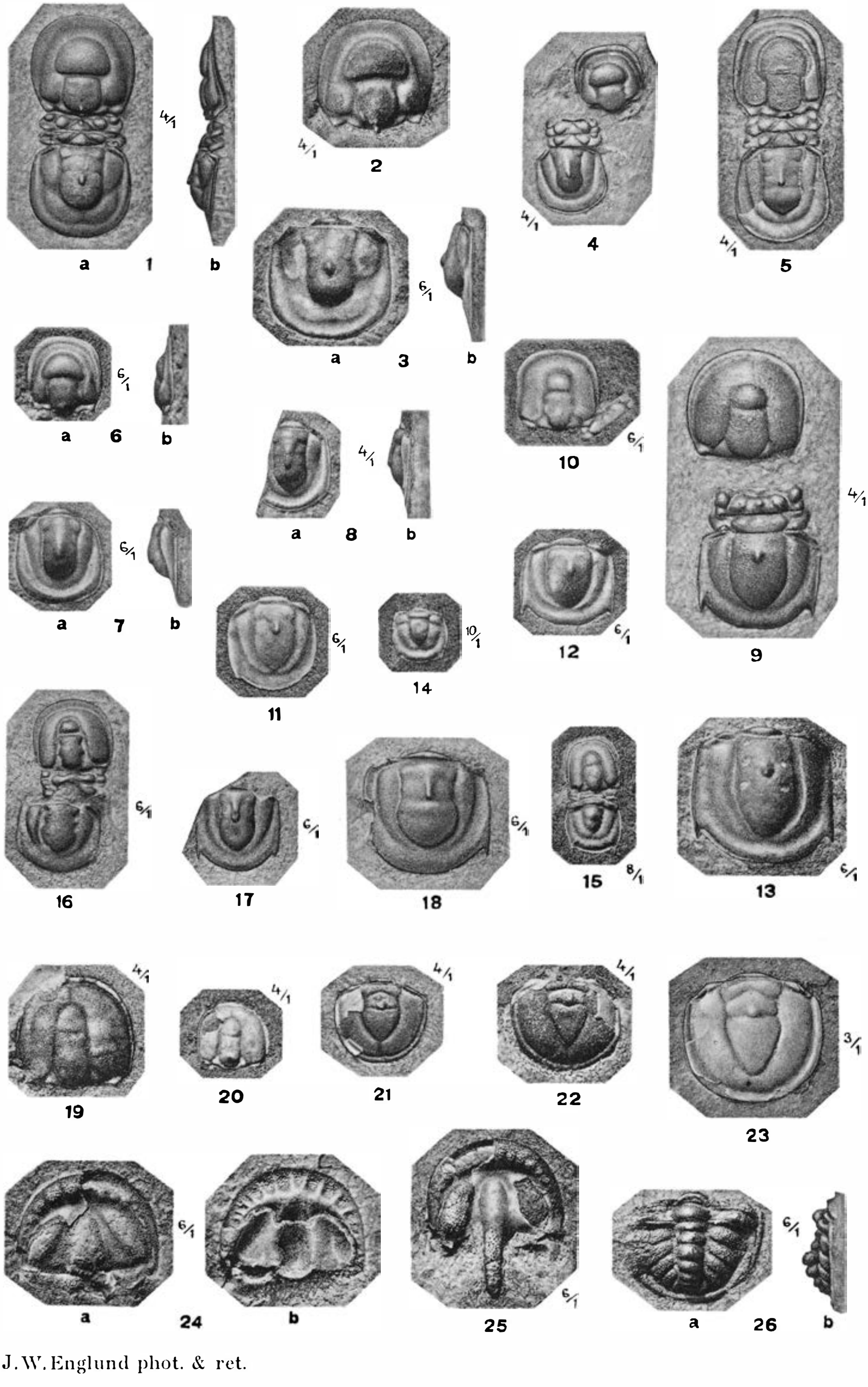
» 16. Complete specimen, somewhat damaged.
» 17 and 18. Pygidia.
Figs. 16—18 are preserved in a dark-grey arenaceous shale and labelled »Öland, Vickleby». — State Museum, Palaeozool. Dept.

Agnostus gibbus praecurrens n. var. Page 29.

» 19. Cephalon. Mossberga; level 8.0 m. — Holotype.
» 20. » Borgholm, well-sinking in 1889.
» 21 and 22. Pygidia. Of the test, only small parts are preserved. Borgholm, well-sinking in 1889.
» 23. Pygidium; test perfectly preserved. Borgholm, well-sinking in 1892.

Calodiscus œlandicus n. sp. Page 30.

» 24 a, b. Cephalon. In a, the test is preserved only in the antero-lateral portion. b shows the counterpart of a. Mossberga; level 7.9 m.
» 25. Cephalon, showing the coarse and blunt occipital spine. Associated with the preceding specimen.
» 26 a, b. Dorsal and side view of pygidium, after a cast of the external mould. Mörbylånga, 1 km SSW of the church. — Holotype.



J.W. Englund phot. & ret.

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Esselte ab. Stockholm

Plate II.

Paradoxides œlandicus SJÖGREN. Page 33.

Fig. 1. Cranidium at a fairly early meraspid stage of development; length 2.6 mm, breadth 3.1 mm. Youngest specimen found which, in all probability, is referable to this species. Mossberga; level 21.9 m.

» 2. Cranidium, external mould; length 3.8 mm, breadth 4.3 mm. Mossberga; level 17.1 m.

» 3. Cranidium, internal cast with very small portions of the test preserved; length 5.6 mm, breadth 6.6 mm. Mossberga, level 13.4 m.

» 4. Complete specimen, internal cast; total length 17.5 mm (cephalon 6.6). Last meraspid stage of development, with 16 thoracic segments. Borgholm. Zone of *Par. pinus.* — State Museum, Palaeozool. Dept.

» 5. Cranidium, in limestone; length 7.6 mm, breadth 8.6 mm. Stora Frö, 7 km NNE of Mörbylånga.

» 6. Cranidium, internal cast; length 15.6 mm, breadth 17.2 mm. Mossberga; level 13.4 m.

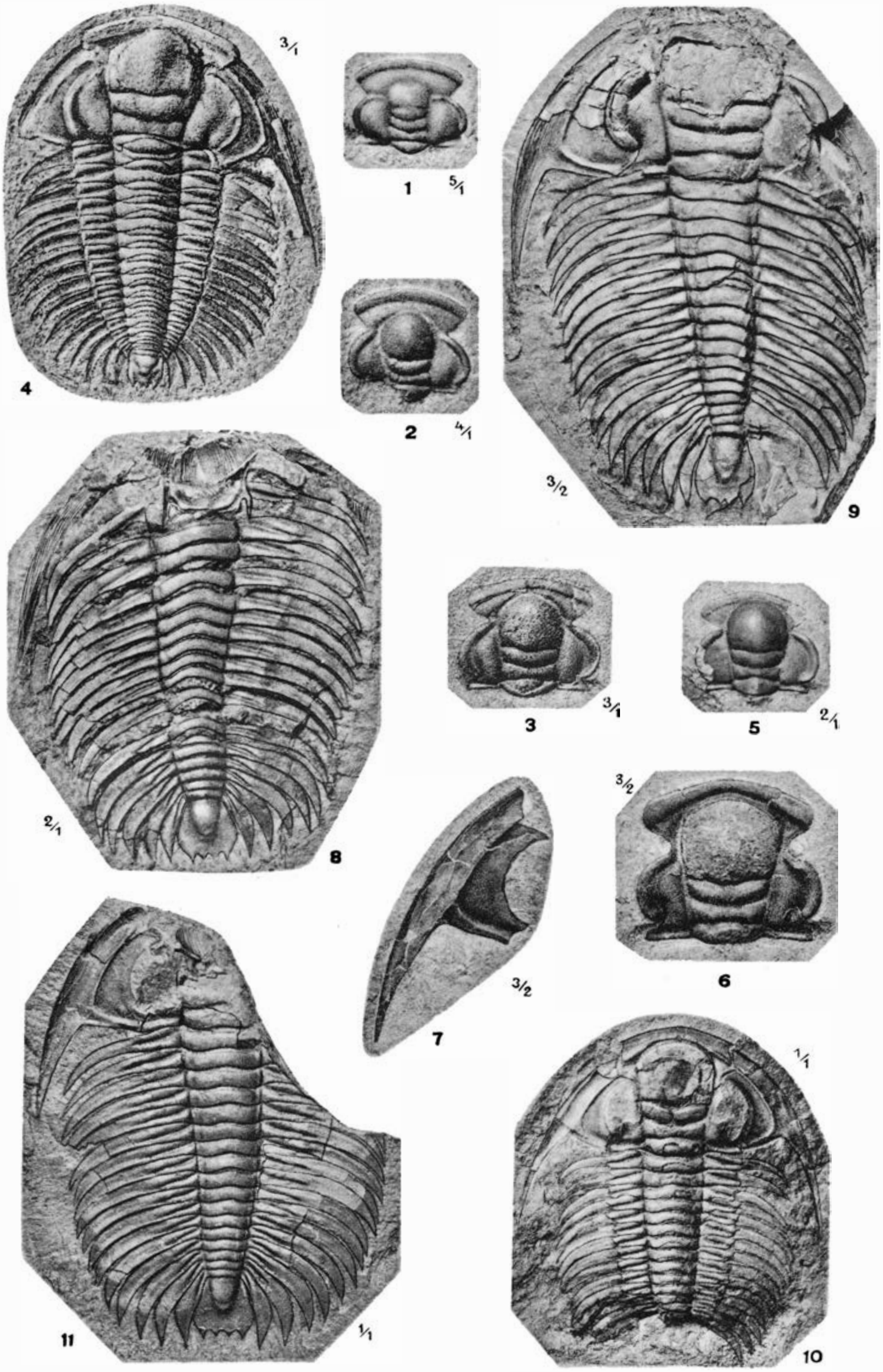
» 7. Free cheek, with the test preserved. Associated with the preceding cranidium.

» 8. Thorax with attached pygidium and part of the hypostoma *in situ.* Borgholm, well-sinking in 1894. Probably lower part of the zone of *Par pinus.*

» 9. Almost complete specimen, with most of the test preserved; total length about 47 mm (cranidium 16). Borgholm. Associated with Fig. 8.

» 10. Cephalon and thorax, internal cast. Length and breadth of cranidium 18.4 mm and 20 mm resp. New figure of Sjögren's Fig. 1, the Holotype. Borgholm or Stora Frö. Judging by the lithological character of the slab, originating from the zone of *Par. insularis.* — State Museum, Palaeozool. Dept. No. Ar. 1449.

» 11. Rather complete specimen. Borgholm. The rock indicates that it was collected from the zone of *Par. insularis.* — State Museum, Palaeozool. Dept.



Figs. 1—3, 5—11, J.W. Englund phot. & ret.
Fig. 4, G. Holm phot., G. Liljevall ret.

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Plate III.

Paradoxides œlandicus SJÖGREN. Page 33.

Fig. 1 a, b. Dorsal and side view of cranidium, in limestone; length 27.4 mm, breadth 28.2 mm. Stora Frö, 7 km NNE of Mörbylånga.
» 2. Cranidium, internal cast; length 32.4 mm, breadth 35.8 mm. Borgholm. Judging by the lithological character of the rock, collected from the *Par. insularis* zone. — State Museum, Palaeozool. Dept., No. Ar. 1383 a.
» 3. Detached thoracic segment, the last one. Probably this species. Borgholm.
» 4. Pygidium of very young specimen; total length 1.8 mm, breadth 1.6 mm. Borgholm, well-sinking in 1889.
» 5. Pygidium. Mossberga; level 15.6 m.
» 6. Pygidium. Borgholm, well-sinking in 1894. Probably lower part of the zone of *Par. pinus*.

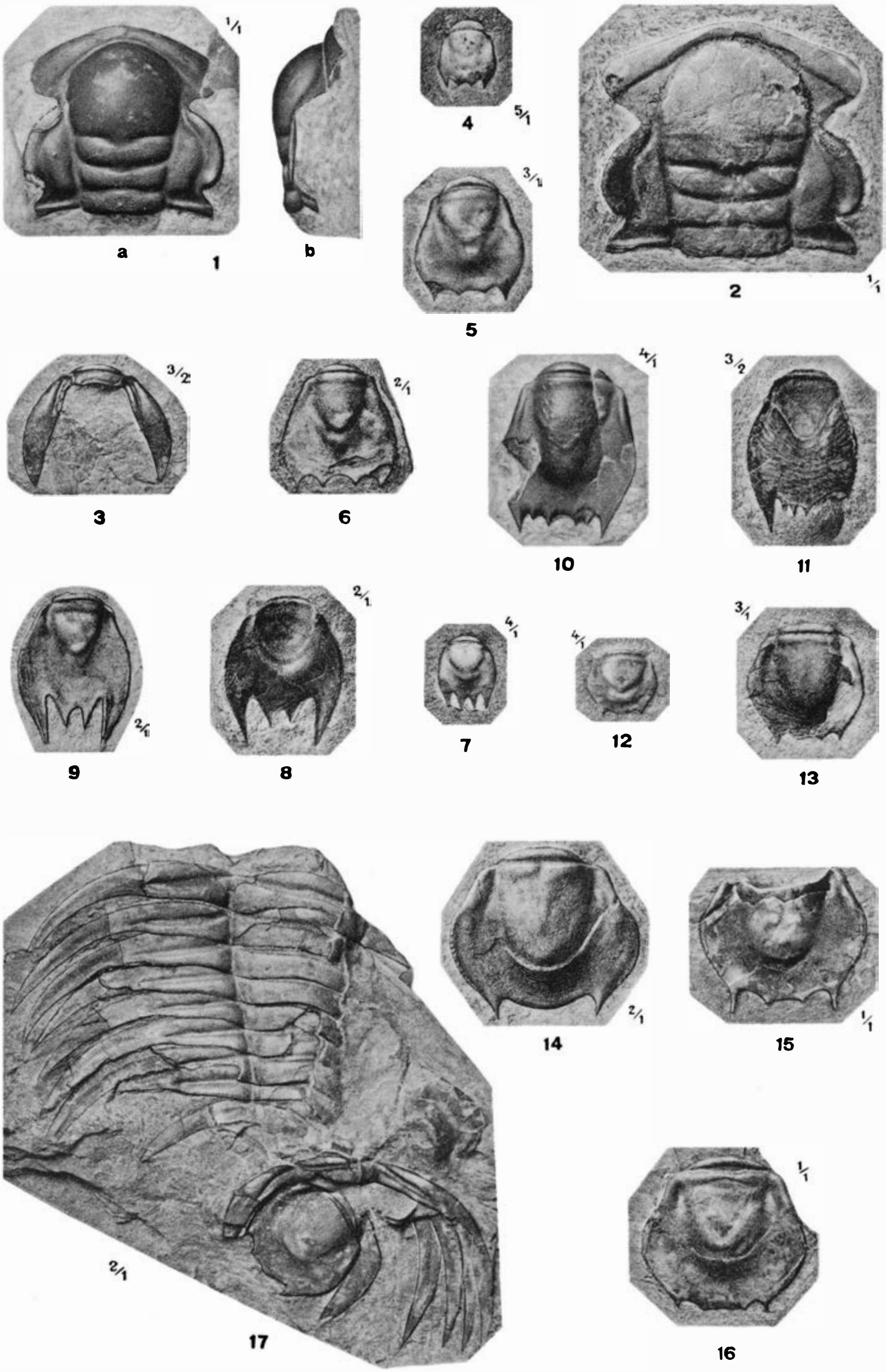
Paradoxides quadrimucronatus HOLM MS. Page 35.

» 7. Pygidium of very young specimen; total length 2.6 mm, breadth 2.6 mm. Probably this species. Mossberga; level 10.35 m.
» 8. Pygidium, external mould. Borgholm, well-sinking in 1892. Zone of *Par. pinus*.
» 9. Pygidium. Borgholm. Zone of *Par. pinus* (?). — Holotype.

» 10. Pygidium with three pairs of marginal spines, in limestone. Variety of *P. œlandicus?* SW of Mörbylånga church. (Boulder?).
» 11. Pygidium with four (?) pairs of marginal spines, showing the under-side of the shell, with the doublure. Possibly a variety of *P. quadrimucronatus*. Mossberga, level 24.4 m.

Paradoxides bidentatus n. sp. Page 36.

» 12. Pygidium of a very young specimen; total length 2.3 mm, breadth 2.4 mm. Borgholm. Zone of *Par. pinus*.
» 13. Pygidium, with the test preserved only on the right lateral lobe; total length 5.4 mm, breadth 5.2 mm. Borgholm, well-sinking in 1892. Zone of *Par. pinus*.
» 14. Pygidium; test preserved on the lateral lobes only. Borgholm, well-sinking in 1889.
» 15. Pygidium. Borgholm, well-sinking in 1892. Zone of *Par. pinus*.
» 16. Pygidium; test preserved on the lateral lobes only. Borgholm.
» 17. Part of thorax with pygidium. Borgholm, well-sinking in 1892. — Holotype.



Figs. 1—13, 16—17, J.W. Englund phot. & ret.
Figs. 14—15, G. Holm phot., G. Liljevall ret.

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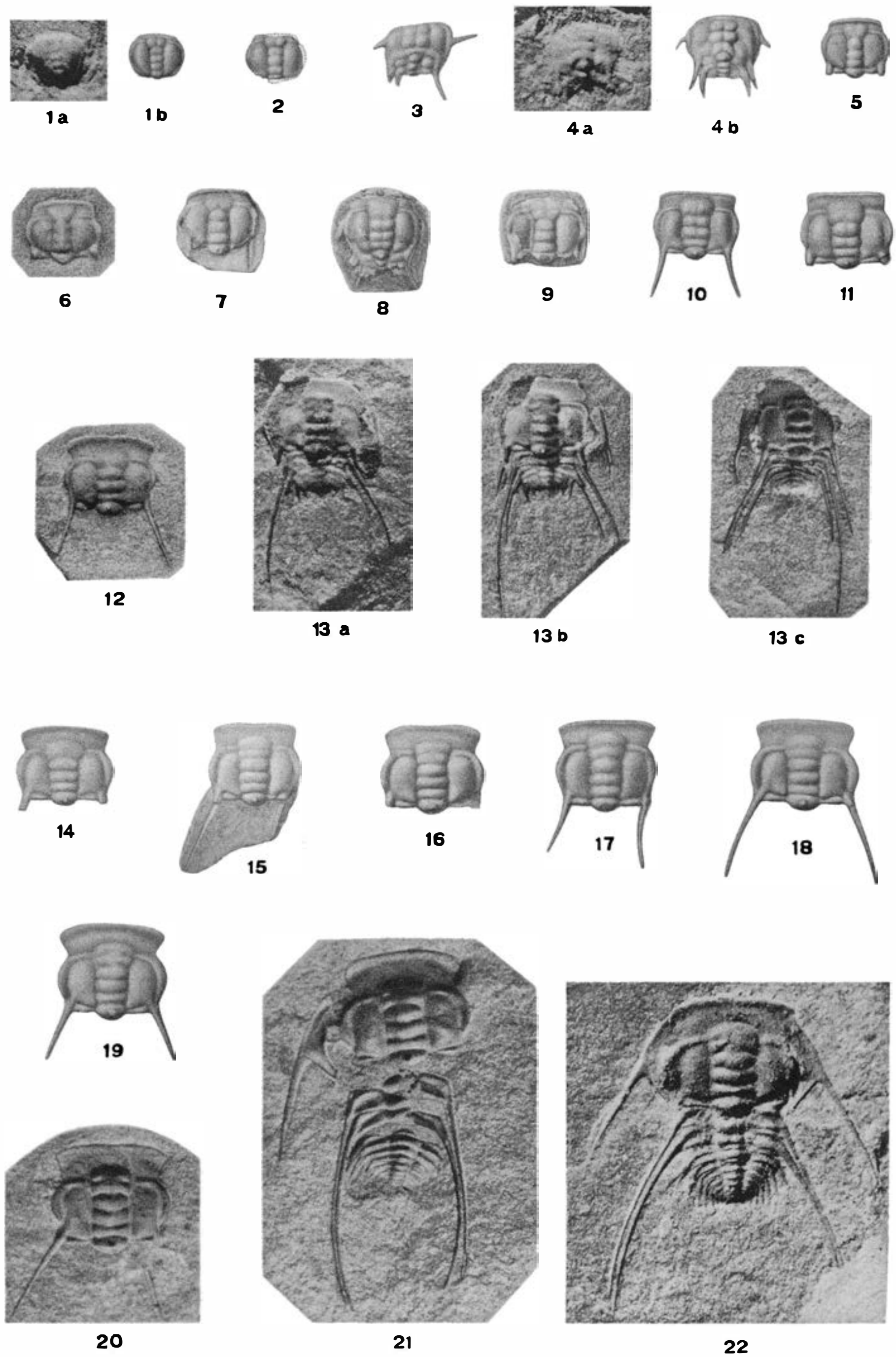
Plate IV.

Larval forms of *Paradoxides* at protaspid and meraspid stages of development, probably belonging to *P. pinus* HOLM MS. Figs. 1—5, 7—11, 14—20, and 22 were collected in 1889 by the late Professor G. Holm from a 3.5 m deep well-sinking at the hospital of Borgholm which seems to have penetrated only the upper part of the *Par. pinus* zone. The remainder are from the boring core at Mossberga, Figs. 6 and 12 from 7.9 m, Figs. 13 and 21 from 9.6 m below the surface. — Page 46.

Fig. 1 a, b (a, unretouched). Earliest protaspid stage found. Length 0.60 mm, breadth 0.75 mm.
» 2. Length 0.65 mm, breadth 0.82 mm.
» 3. Late protaspid stage. Disfigured by compression. Breadth 0.94 mm.
» 4 a, b (a, unretouched). Total length (spines excluded) 0.82 mm (cephalon 0.71), breadth 1.01 mm.
» 5. Cranidium; length 0.82 mm, breadth 0.94 mm.
» 6. » » 0.84 » » 0.97 »
» 7. » » 0.88 » » 0.99 »
» 8. Specimen at a late protaspid stage? Total length 1.03 mm (cephalon 0.90), breadth 1.01 mm.
» 9. Cranidium; length 0.92 mm, breadth 1.05 mm.
» 10. » » 0.94 » » 1.16 »
» 11. » » 1.05 » » 1.18 »
» 12. » » 1.12 » » 1.31 »
» 13 a—c (a, unretouched; c, counterpart of a). Almost complete specimen; total length, the spines not included, 1.50 mm (cranidium 1.12), breadth of cranidium about 1.25 mm.
» 14. Cranidium; length 1.12 mm, breadth 1.31 mm.
» 15. » » 1.14 » » 1.27 »
» 16. » » 1.20 » » 1.42 »
» 17. » » 1.27 » » 1.31 »
» 18. » » 1.27 » » 1.54 »
» 19. » » 1.35 » » 1.50 »
» 20. » external mould; length 1.42 mm, breadth 1.59 mm.
» 21. Almost complete specimen, external mould; total length about 2.7 mm (cranidium 1.55), breadth of cranidium 1.76 mm.
» 22. Complete specimen, unretouched; total length, apart from the spines, 2.7 mm (cranidium 1.57), breadth of cranidium 1.76 mm.



All Figs. magnified 10 times

Figs. 1—11, 14—19, G. Holm phot. & G. Liljevall ret.
Figs. 12—13, 20—22, J. W. Englund phot. & ret.

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Plate V.

Paradoxides pinus Holm MS. Specimens at late meraspid and early holaspid stages of development. Figs. 1—4 and 8 are from the boring core of Mossberga, the remainder were collected by G. Holm from a well-sinking in 1889 at the Borgholm hospital. — Page 49.

Fig.	1.	Cranidium;	length	1.84	mm,	breadth	1.95	mm.	Mossberga;	level 6.3 m.
»	2.	»	»	2.2	»	»	2.4	»	»	» 6.3 »
»	3.	»	»	2.4	»	»	2.7	»	»	» 9.6 »
»	4.	»	»	2.7	»	»	3.0	»	»	» 9.6 »
»	5.	»	»	3.1	»	»	3.5	»		
»	6.	»	»	3.6	»	»	4.1	»		

» 7. Almost complete specimen at a late meraspid stage (Degree 14?); internal cast. Length and breadth of cranidium 3.8 and 4.6 mm resp.

» 8. Cranidium; length 4.6 mm, breadth 5.3 mm. Mossberga; level 10.2 m.

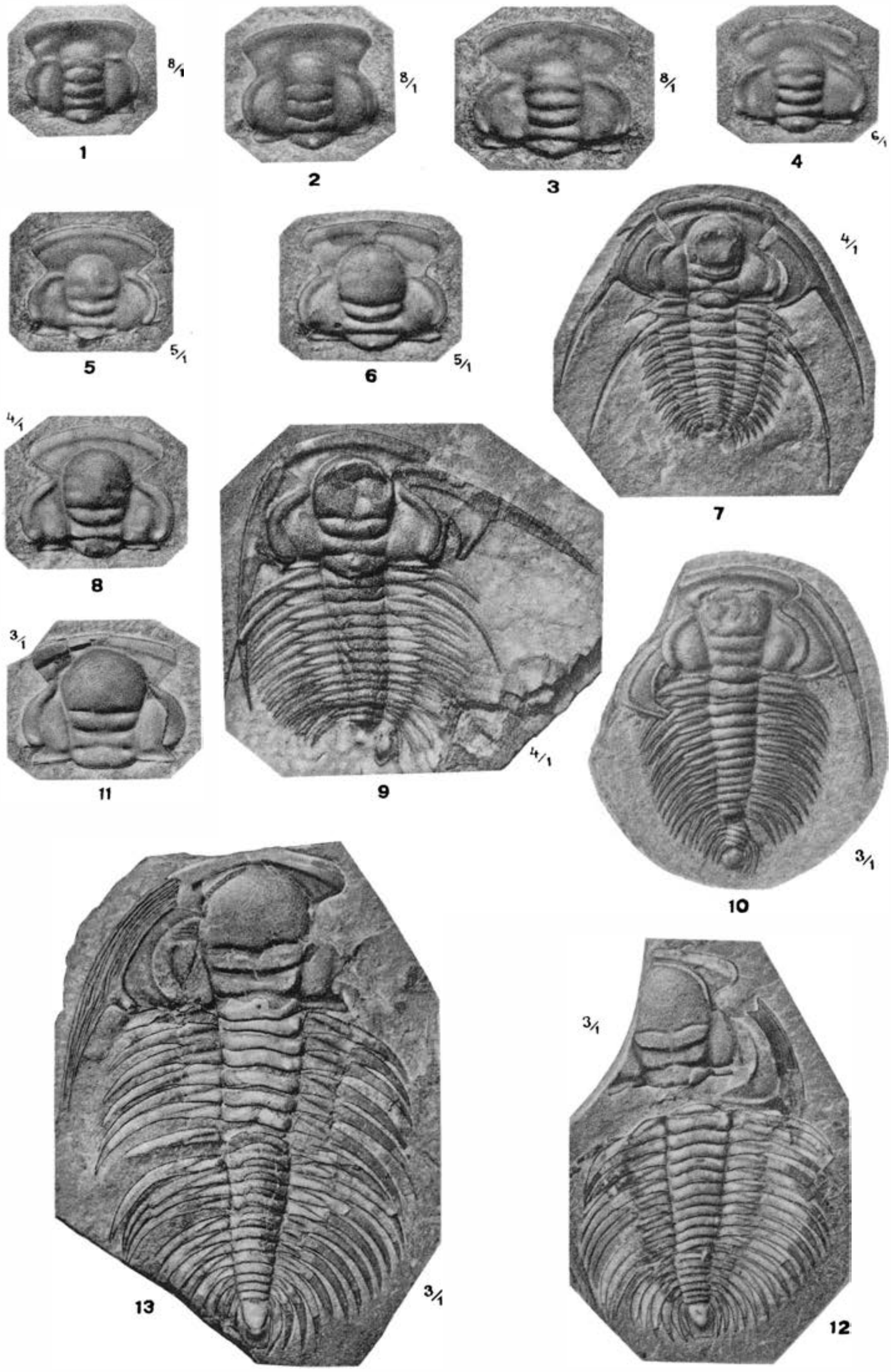
» 9. Rather complete specimen. Length and breadth of cranidium 4.9 and 6.0 mm resp.

» 10. Complete specimen at the earliest holaspid stage found. Total length about 13.5 mm, length and breadth of cranidium 5.3 and 6.6 mm resp.

» 11. Cranidium; length 6.1 mm, breadth 7.6 mm.

» 12. Rather complete specimen; total length 18 mm (cranidium 7.0 mm).

» 13. Rather complete specimen; total length 24 mm, length of cranidium 8.2 mm. — Holotype.



Figs. 1—9, 11—13, J. W. Englund phot. & ret.
Fig. 10, G. Holm phot., G. Liljevall ret.

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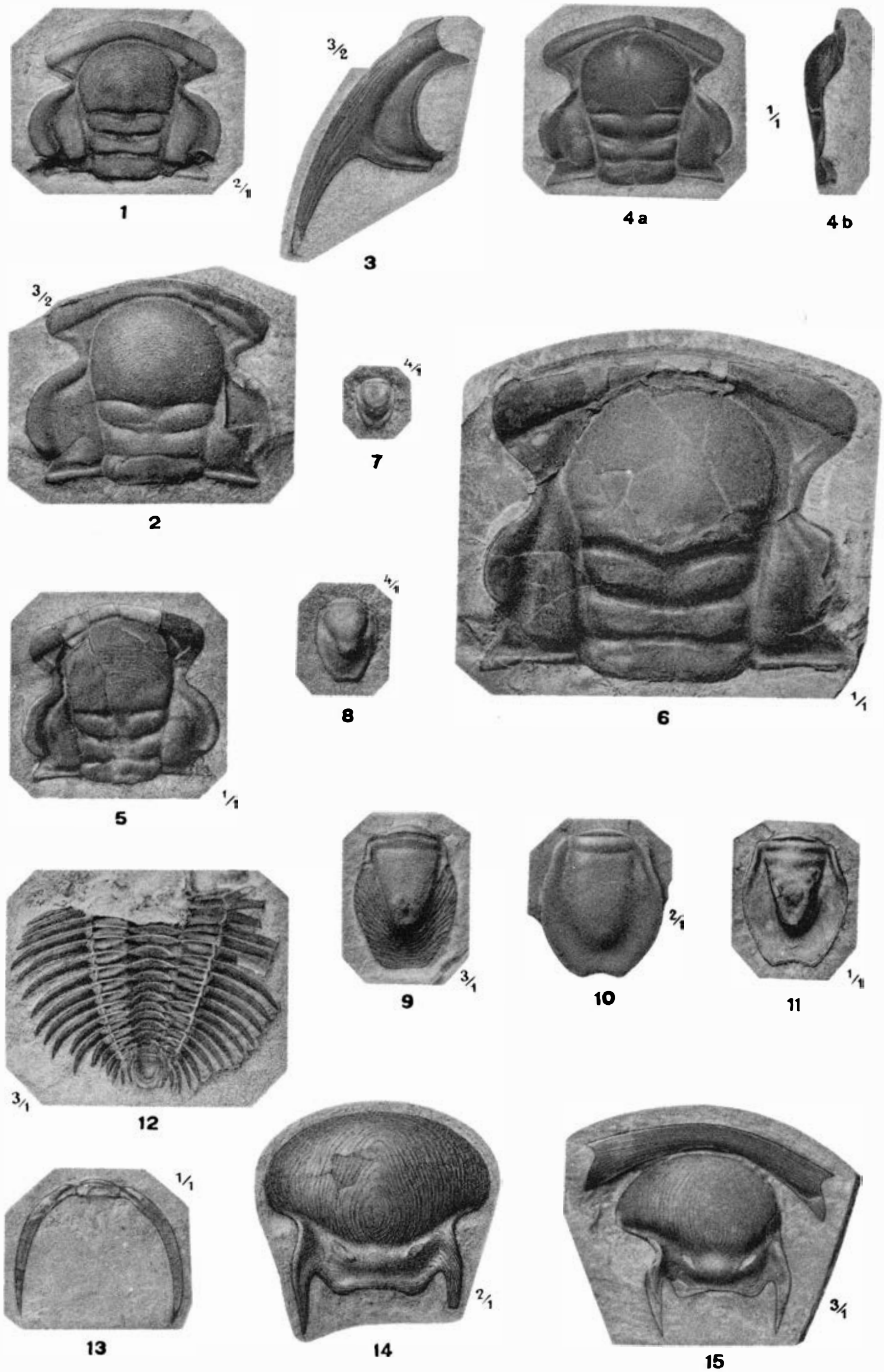
Plate VI.

Paradoxides pinus HOLM MS. Specimens at holaspid stages of development Page 38.

Fig. 1. Cranidium; length 11.0 mm, breadth 13.4 mm. Mossberga; level 7.9 m.
» 2. » » 19.2 » » 22.5 » » » 7.7 »
» 3. Free cheek, in limestone; associated with the cranidium in Fig. 4. Borgholm; boulder.
» 4 a, b. Dorsal and side view of cranidium, in limestone; length 23.5 mm, breadth 26.3 mm. Associated with the cheek in Fig. 3.
» 5. Cranidium; length 24.8 mm, breadth 27.0 mm. Borgholm, well-sinking in 1892.
» 6. Cranidium; length 47 mm, breadth 49 mm. Borgholm, well-sinking in 1889.
» 7. Pygidium of very young specimen; length 1.6 mm, breadth 1.4 mm. Borgholm, well-sinking in 1889.
» 8. Pygidium of young specimen; length 2.8 mm, breadth 2.1 mm. Associated with the preceding specimen.
» 9. Pygidium, internal cast showing the striated doublure; length 6.9 mm, breadth 4.7 mm. Mossberga; level 9.2 m.
» 10. Pygidium; length 10.2 mm, breadth 8.2 mm. Mossberga; level 7.9 m.
» 11. Pygidium; length 18.0 mm, breadth 14.5 mm. Borgholm, well-sinking in 1889.
» 12. Thorax with attached pygidium, seen from the under-side, showing the doublure of the pleura. Borgholm, well-sinking in 1889.
» 13. Detached thoracic segment, one of the last ones. Borgholm, well-sinking in 1892.
» 14. Hypostoma. Borgholm, well-sinking in 1889.
» 15. Hypostoma with rostrum *in situ*, probably this species. (Of the associated *Paradoxides* species, *P. pinus* is very common whilst *P. œlandicus* is rare.) Borgholm. — State Museum, Palaeozool. Dept.



Figs. 1—13, 15, J. W. Englund phot. & ret.
Fig. 14, G. Holm phot. & G. Liljevall ret.

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Plate VII.

Paradoxides insularis n. sp. Page 39.

Fig. 1. Cranidium of young specimen; length 5.2 mm, breadth 6.6 mm. Mossberga; level 20.4 m.

» 2 a, b. Cranidium. b, part of the glabella magnified eight times to show the granulation of the test. Mossberga; level 23.9 m.

» 3. Defective cranidium, with the test preserved only in the posterior part. Mossberga; level 20.1 m.

» 4. Pygidium, showing part of the striated doublure. Mossberga; level 23.4 m.

» 5. Cranidium, with small parts of the test preserved; in limestone. Strandtorp, 5.5 km SSW of Borgholm.

» 6. Free cheek, under-side. Associated with Fig. 5.

» 7. Part of thorax, with attached pygidium. Associated with Fig. 5.

» 8. Cranidium, internal cast. Borgholm; deep boring in 1900, level 11.2 m.

» 9. Cranidium, with the first thoracic segment attached and two detached hypostomata; internal cast in limestone. Borgholm; boulder. — Holotype.

Paradoxides sp. No. 2. Page 43.

» 10. Pygidium, showing part of the striated doublure. Borgholm, well-sinking in 1892.

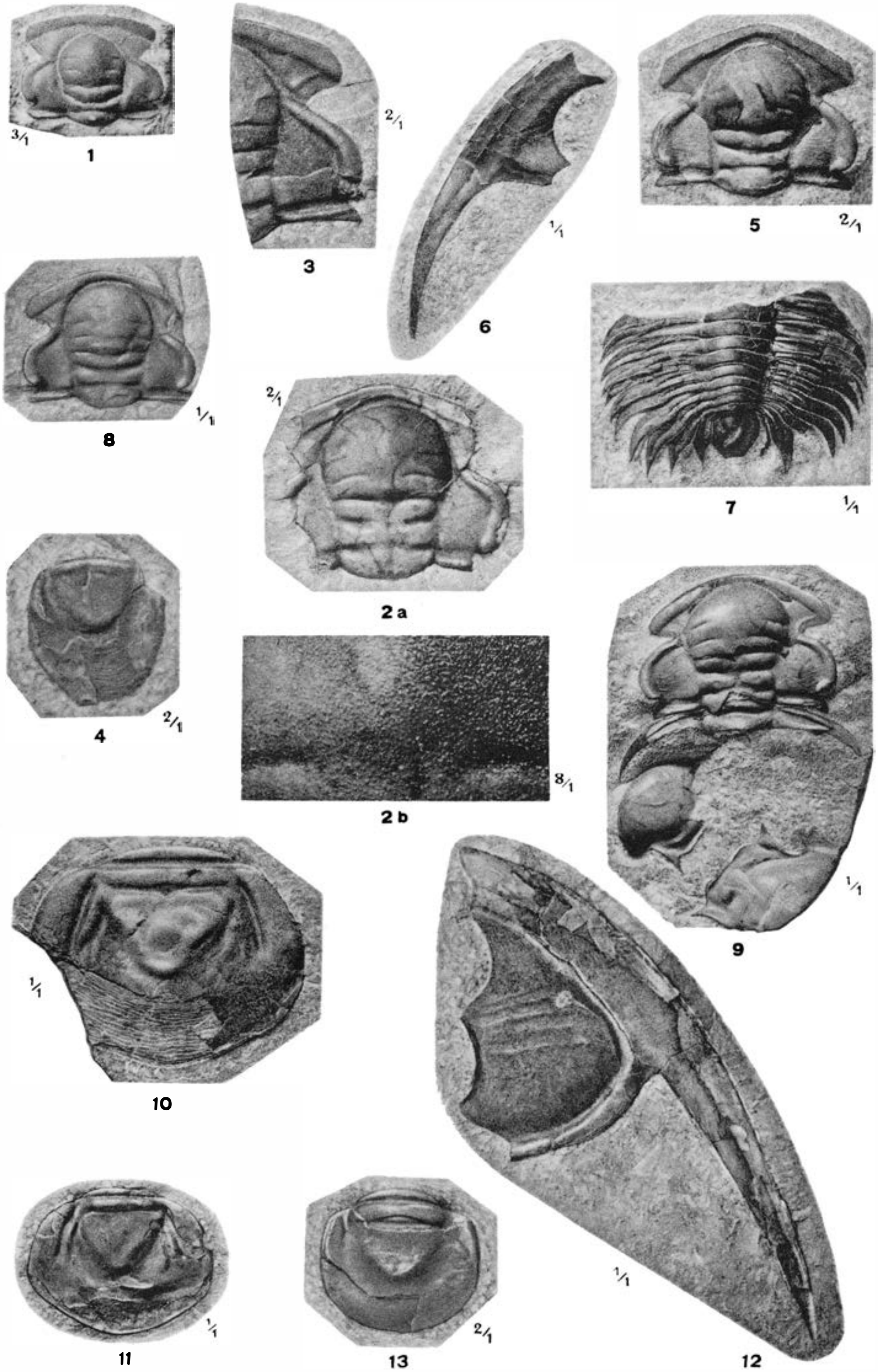
» 11. Pygidium. Associated with Fig. 10.

Paradoxides sp. No. 3. Page 44.

» 12. Free cheek. Borgholm, well-sinking in 1892.

Paradoxides sp. No. 4. Page 45.

» 13. Pygidium, after cast of external mould. Borgholm, well-sinking in 1894.



J. W. Englund phot. & ret.

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Plate VIII.

Paradoxides torelli HOLM MS. Page 40.

Figs. 1 a—b. Complete specimen; b, counter-part (external mould) of a. — Holotype.

Fig. 2. Part of thorax with attached pygidium. The pleural spine of the penultimate thoracic segment was broken off while the animal lived and was then cicatrized.

» 3. Pygidium.

» 4. Pygidium coalesced with the right pleuron of the last thoracic segment which, otherwise, seems to be free. (Compare Pl. IX.)

Figs. 1—4 from a well-sinking in 1889 at Borgholm.

Paradoxides (?) sp. indet.

» 5. Hypostoma of very young specimen. Length 0.73 mm. Borgholm, well-sinking in 1889.

Œlandia pauciplicata n. gen. et n. sp. Page 25.

» 6. Complete specimen, side view. Photographed with the light from below. — Holotype. — Borgholm, well-sinking in 1889.

» 7 a, b. Defective specimen, seen from the side and from the convex slope; internal cast with small parts of the test preserved. In limestone. Stora Frö, 7 km NNE of Mörbylånga.

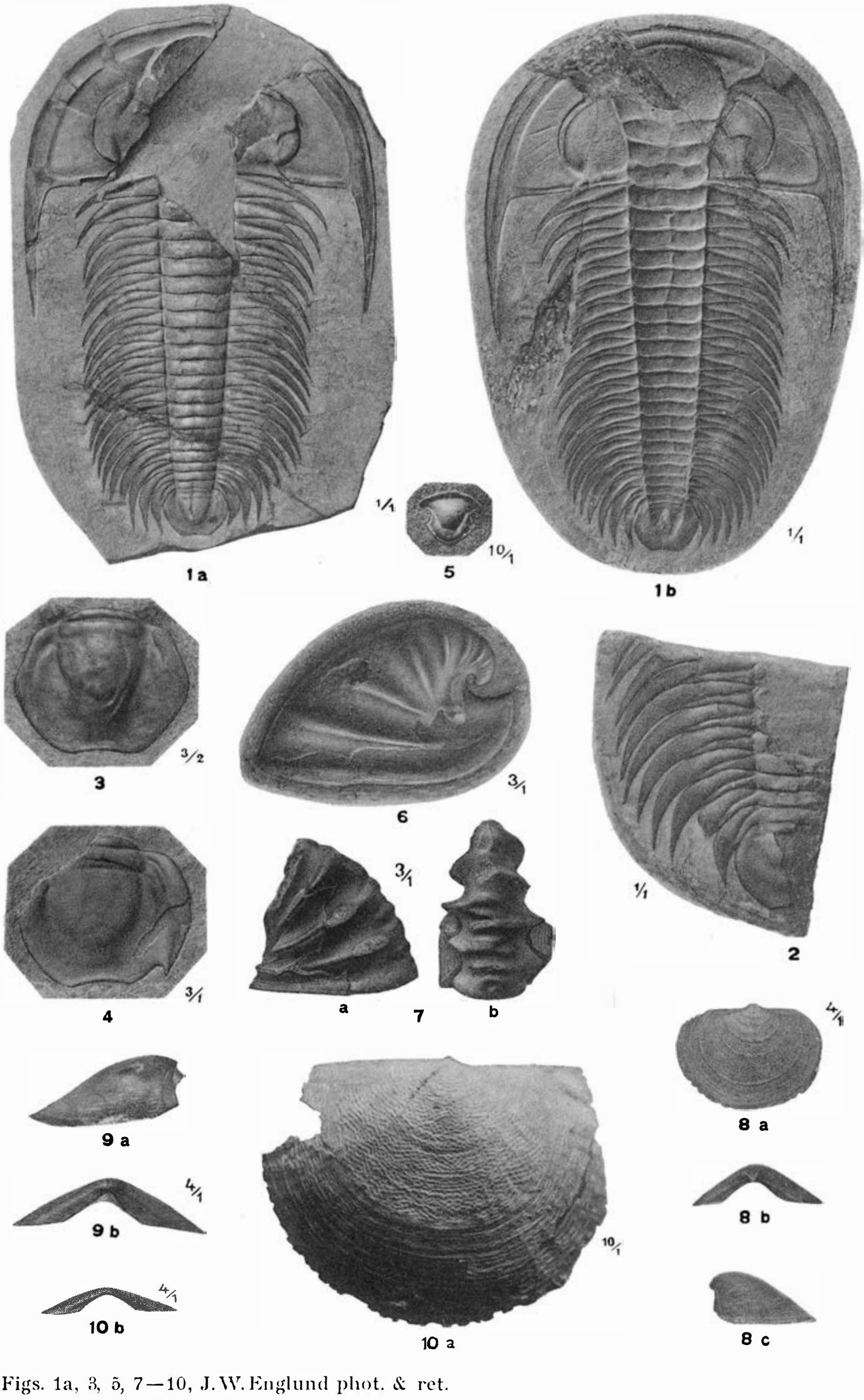
Micromitra (*Iphidella*) *ornatella princeps* n. var. Page 22.

» 8 a—c. Ventral valve; apical, posterior, and side views. Pseudodeltidium absent (broken off). — Holotype.

» 9 a—b. Exfoliated and somewhat compressed ventral valve; side and posterior views.

» 10 a—b. Dorsal valve, apical and posterior views.

The specimen in Figs. 8—10 were found in two boulders of a greenish grey argillaceous and arenaceous limestone collected at Berg in Östergötland. Associated species: *Acrothele granulata*, *Lingulella ferruginea*, *Ellipsocephalus polytomus*.



Figs. 1a, 3, 5, 7—10, J. W. Englund phot. & ret.
Figs. 1b, 2, 4, 6, G. Holm phot., G. Liljevall ret.

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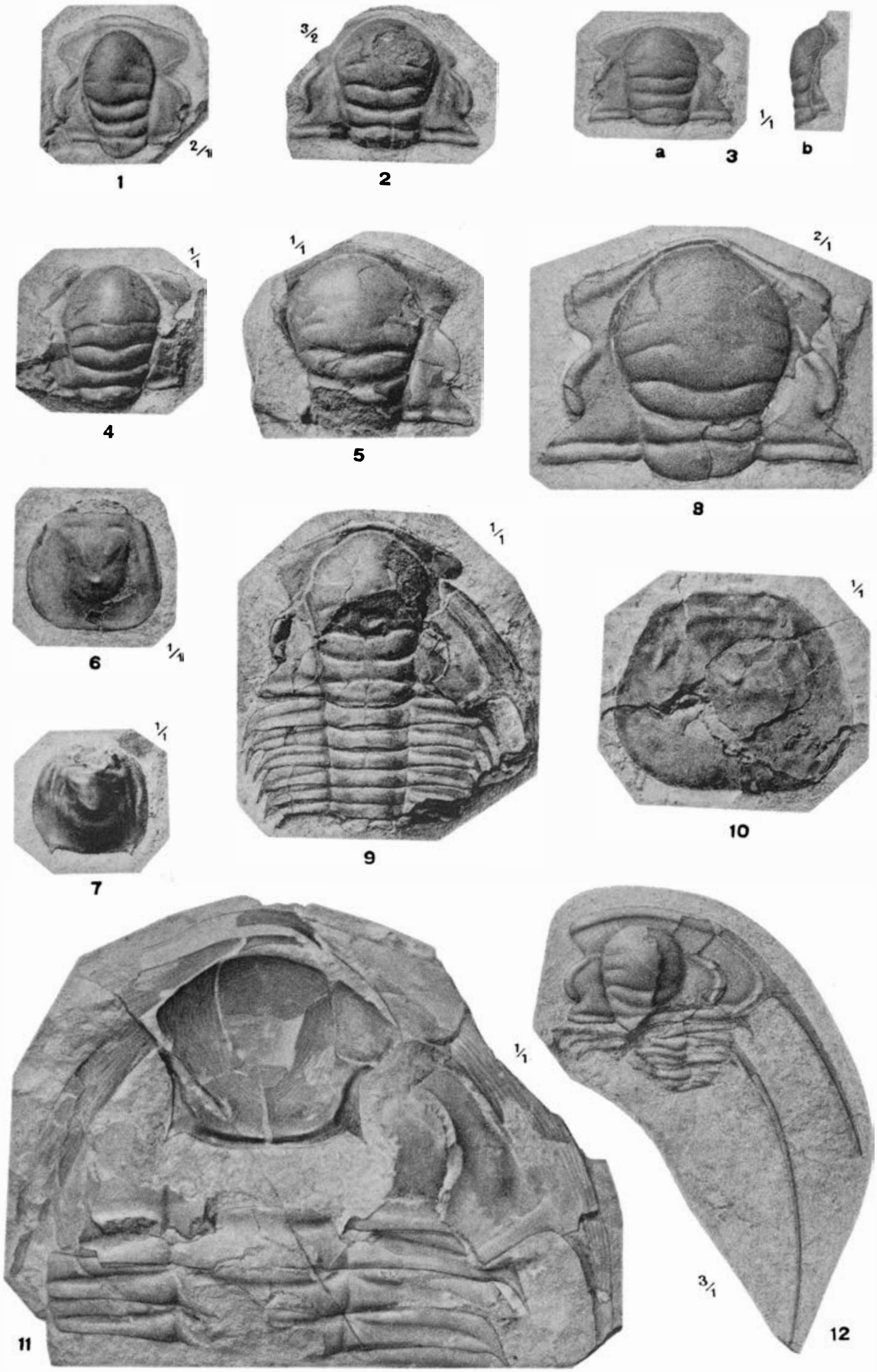
Plate IX.

Paradoxides sjögreni LINNARSSON. Page 41.

Fig. 1. Cranidium of young specimen; length 10.0 mm. Mossberga; level 13.2 m.
» 2. Cranidium, internal cast in limestone; length 13.7 mm. New Figure of Linnarsson's specimen Fig. 8. Stora Frö, 7 km NNE of Mörbylånga.
» 3 a, b. Dorsal and side view of cranidium, in limestone. Test very finely granulated. Stora Frö.
» 4. Defective cranidium, internal cast in limestone. New figure of Linnarsson's specimen Fig. 7. Stora Frö. — Holotype.
» 5. Defective cranidium, in limestone, with small and scattered parts of the test preserved. Stora Frö.
» 6. Pygidium, internal cast in limestone. New figure of Linnarsson's specimen Fig. 9. Stora Frö.
» 7. Pygidium, in limestone. Distinct from the typical form in having a pair of very small marginal points. This species? Stora Frö.
» 8. Cranidium. The convexity of the border in front of the glabella probably is secondary and caused by compression. Borgholm, well-sinking in 1889.
» 9. Cranidium, displaced right free cheek, and part of thorax. Borgholm, well-sinking in 1894.
» 10. Pygidium, seen from the inside. Largest pygidium found. Associated with Fig. 9.
» 11. Parts of cephalon and thorax, with hypostoma *in situ* (inside), in limestone. Mörbylånga; boulder.
» 12. Cranidium, the right free cheek, and part of thorax of an immature specimen. Length and breadth of cranidium 5.9 and 7.4 mm resp. Borgholm, well-sinking in 1889.

Figs. 2 (No. Ar. 1357), 4 (No. Ar. 1358 f), and 6 (No. Ar. 1477) belong to the Palaeozool. Dept. of the State Museum.



Figs. 1—11, J. W. Englund phot. & ret.
Fig. 12, G. Holm phot., G. Liljevall ret.

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Plate X.

Paradoxides sjögreni LINNARSSON. Page 41.

Complete specimen, in limestone. Nat. size.

It is deformed in so far as the right pleuron of the last thoracic segment is anchylosed with the pygidium (compare Pl. VIII, Fig. 4). Mörbylånga; boulder. Collected by Dr. Sten Kallenberg. — Museum of Kristianstad.

1/1

G. Holm phot. G. Liljevall ret.

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Plate XI.

Bailiella emarginata (LINNARSSON). Page 58.

Fig. 1. Rather complete specimen, in limestone. Test preserved except in the glabella. Vickleby (probably Stora Frö). No. Ar. 1557.

» 2 a—b. Dorsal and side view of cephalon, in limestone. Parts of the test preserved. Vickleby (probably Stora Frö). No. Ar. 1556 c.

» 3 a—b. Dorsal and side view of pygidium, in limestone. Stora Frö.

Figs. 1 and 2 belong to the Palaeozool. Department of the State Museum.

Fig. 4. Hypostoma, probably of *Lichas*. — The slab, which belongs to the Palaeozool. Dept. of the State Museum, is marked »Borgholm» in ink-writing, and the annexed label runs thus: »Paradoxides. Borgholm, Öland, H. A. R. Sidén leg.» Lithologically, the slab agrees perfectly with a collection of greenish grey arenaceous Oelandicus shale from Borgholm which Sidén in 1876 presented to the Museum just mentioned. However, after this plate was printed a few very small, smooth ostracods were discovered on the slab. Consequently, the slab originates from younger strata (Ordovician), and, if it was indeed collected at Borgholm, it was probably taken from a boulder.

Ellipsocephalus polytomus LINNARSSON. Page 56.

» 5. Cranidium. Youngest specimen found; length 2.4 mm. Borgholm, well-sinking in 1889.

» 6. Almost complete specimen in the meraspid Degree 11. Total length 6 mm (cranidium 2.7). Borgholm, well-sinking in 1889.

» 7. Cranidium and first thoracic segment. Length of cranidium 2.8 mm. Borgholm, well-sinking in 1889.

» 8. Almost complete specimen at an early holaspid stage. Total length about 12.5 mm (cranidium 4.9). Väster-Skucku, Jämtland.

» 9 a—c. Completely enrolled specimen in different aspects, preserved in limestone. Length of cranidium 5.2 mm. Borgholm.

» 10 a—b. Cranidium and the first thoracic segment in different aspects; in limestone. Length of cranidium 7.2 mm. Borgholm, well-sinking in 1889.

» 11. Complete specimen. Total length 30 mm (cephalon 11.5). Borgholm.

» 12 a—b. Dorsal and side view of cranidium. Length 13.4 mm. Test preserved only in the posterior part. Mossberga; level 9.2 m.

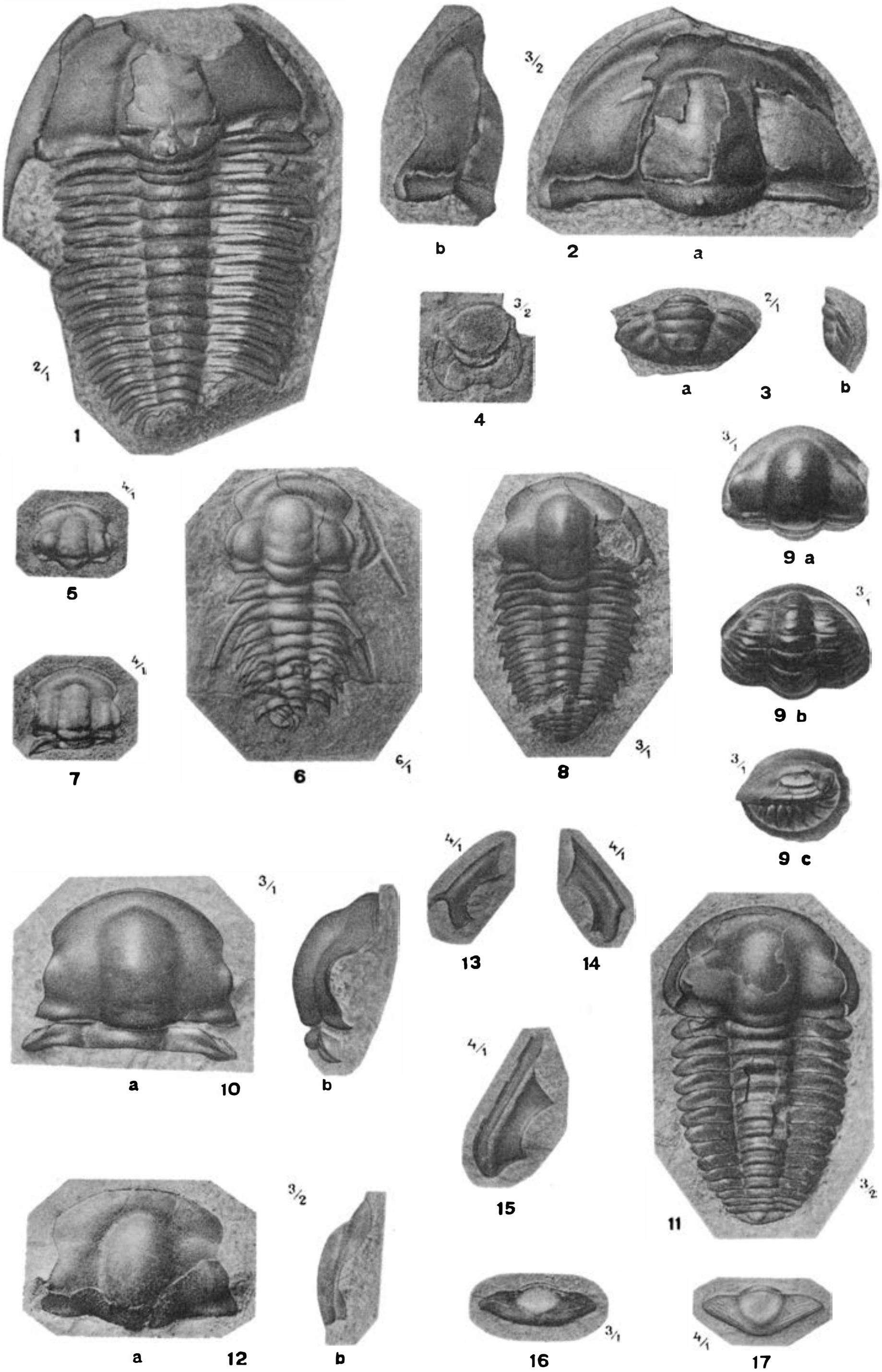
» 13. Free cheek of young specimen, with well developed genal spine. Borgholm, well-sinking in 1889.

» 14. Free cheek; the genal spine is replaced by a small projection. Borgholm, well-sinking in 1889.

» 15. Free cheek, internal cast showing the doublure. The traces of the genal spine wholly obliterated. Borgholm, well-sinking in 1889.

» 16. Pygidium. Mossberga; level 7.7 m.

» 17. Pygidium. Borgholm, well-sinking in 1889.



Figs. 1—5, 7—17, J. W. Englund phot. & ret.
Fig. 6, G. Holm phot., G. Liljevall ret.

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Plate XII.

Solenopleura cristata LINNARSSON. Page 59.

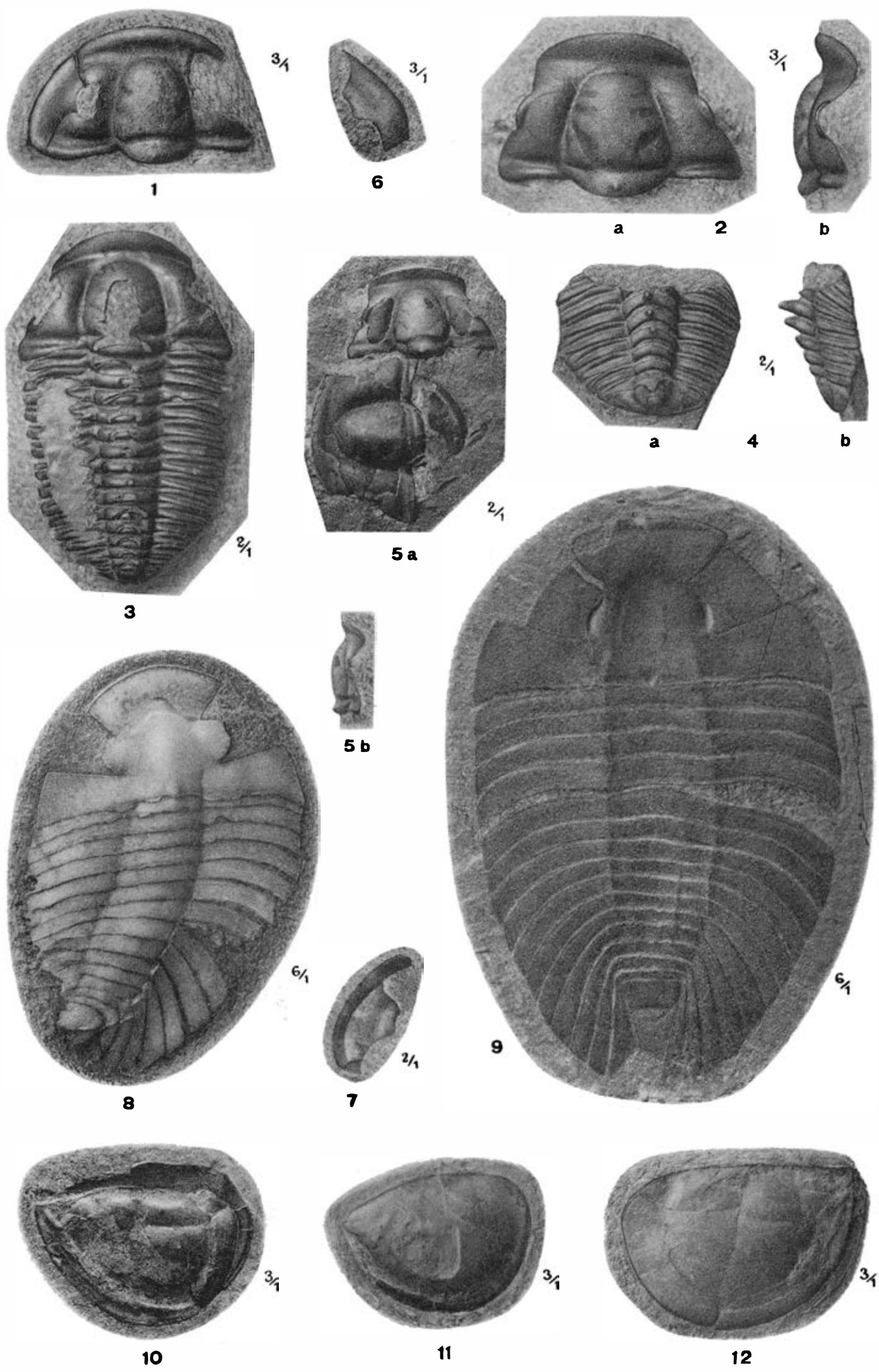
Fig. 1. Cranidium and the left free cheek *in situ*. New figure of Linnarsson's Fig. 5. Borgholm. — State Museum, Palaeozool. Dept., No. Ar. 1456 b. — Holotype.
» 2 a—b. Cranidium in different aspects; in limestone. Alböke.
» 3. Almost complete specimen, in limestone. Borgholm.
» 4 a—b. Posterior part of thorax, with attached pygidium, in different aspects. Borgholm.
» 5 a—b. Two cranidia; b, side-view of the smaller one. Mossberga; level 12.2 m.
» 6. Free cheek. Mossberga; level 11.6 m.
» 7. Free cheek seen from the under-side, showing the doublure. Associated with Fig. 6.

Burlingia laevis WESTERGÅRD. Page 32.

» 8. Rather complete specimen. Borgholm, well-sinking in 1889.
» 9. Complete specimen, external mould. Borgholm, well-sinking in 1889. — Holotype.

Hymenocaris (?) *œlandica* HOLM MS. Page 61.

» 10. Left side view of a carapace which has cracked along the dorsal line owing to the pressure of the shaly matrix and has the halves somewhat displaced; part of the right side visible. — Holotype.
» 11. Left side view of carapace, lacking most of the test.
» 12. Right side view of carapace; external mould.
Figs. 10—12 originate from the zone of *Par. pinus* at Borgholm.



Figs. 1—7, 10, J. W. Englund phot. & ret.
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