The Middle Ordovician of the Oslo Region, Norway, 32.
Trilobites of the family Remopleurididae

FRANK NIKOLAISEN


The Middle Ordovician remopleurid trilobites of the Oslo Region are described in detail. From the fragmentary but very often well preserved material six genera are recognized, of which Sculptaspis and Sculptaspis are new. A seventh genus, Robergiella, may also be present. Eighteen new species are established; four other named species are known also from elsewhere, and one species previously described from Norway is reported. Fifteen taxa are described under open nomenclature. The Norwegian species can be compared with those occurring in the Middle and Upper Ordovician of the Swedish-Baltic area, the British Isles and even North America and China. The genus Sculptaspis is known with certainty only from Norway, but may be present in Ireland and China; Sculptaspis is reported from Sweden, Estonia, and may also be present in Bornholm (Denmark), Ireland, and eastern North America. A phylogenetic line from Remopleuridella through Sculptaspis to Remopleurella and Amphitryon is suggested, possibly with Sculptaspis as a separate branch. The British species Remopleurides warburgae Dean, 1963 is renamed R. deani as the former name is preoccupied.

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Introduction

The present paper appears as no. 32 in a series dealing with the Middle Ordovician palaeontology, stratigraphy and tectonics of the Oslo Region. A team work on this subject was inititated by the late Professor Leif Størmer in 1950, supported by grants from the Norwegian Council for Science and Humanities (NAVF).

The present paper appears as no. 32 in a series reported by grants from the Norwegian Council for Science and Humanities (NAVF).

The term “Middle Ordovician” is here taken in the sense of Størmer (1953), i.e. from the Llanvirn zone of Didymograptus bifidus to the Caradoc zone of Dicranograptus clingani.

The stratigraphical units referred to in the text are partly those of the traditional “etasje” classification of the Lower Palaeozoic sequences in the Oslo Region. In other cases, the author has referred to lithostratigraphical units with names in accordance with the recommendations of the International Stratigraphic Guide (1976). Such units have been established for parts of the Middle Ordovician in several of the Oslo Region districts, especially in recent years as steps towards achieving a complete coverage of these Lower Palaeozoic sequences (cf. Owen 1978, 1979, Bruton & Owen 1979). A correlation chart partly used in the present work (Table 1) will be published by Bockelie (1983 in press).

Remopleuridid trilobites are some of the most widespread and common trilobites in the Middle Ordovician sequences of the eleven districts of the Oslo Region (Størmer 1953, Fig. 1). Remopleurids are reported herein from all the districts except Feiring and Holmestrand, yet none has been described previously except the pygidium assigned to Lichas 4-spinus by Angelin (1854) and Remopleurides latus granensis Størmer, 1945. Angelin’s specimen cannot be traced in the collections, whereas the latter species was redescribed by Owen (1981) in his monograph on the Upper Ordovician trilobites of the Oslo Region, where he also described several other remopleurids.

The Middle Ordovician material is fragmentary, but the preservation is predominantly good, and thus merits detailed description. In the course of the study all available museum specimens were examined. On larger blocks, the fossil was sawn out, and the residue was cracked and thoroughly examined. This has produced a larger number of assorted detached parts of the exoskeleton of the different species; very often small parts that are easily overlooked in the field. Collecting has been done over a period of about ten years. Most of the material consists of detached parts of the dorsal shield; satisfactory and complete dorsal shields are known in only four of the species. Nevertheless, it seems quite natural to match detached parts together, because each species usually occurs in thin rock sequences, and in some cases geographically restricted areas.

The remopleurids seem to have been a fairly rapidly evolving group of trilobites, although the changes are usually small. This has produced a large number of recognizable species in the Middle Ordovician of the Oslo Region, and the same is apparently the case in the British Isles and North America. The differences between some forms may appear small, but the present author considers them to merit specific, rather than subspecific or varietal differentiation.

In previous publications dealing with Remopleurides, authors have mainly based the specific characters on features of the cranidium and/or the pygidium. The present study has shown that librigenae and thoracic segments are of equal, or in some cases even greater, value in specific differentiation. The presence or absence of lateral glabellar furrows has previously been given considerable taxonomic weight. The present material includes many smooth specimens with the test preserved. In these specimens the lateral glabellar furrows are discernible only as differences in colour, caused by the thinner test at these furrows (cf. pl. 3, fig. 7). Occasionally, the lateral glabellar furrows are recognized as extremely shallowly elevated areas (cf. Pl. 8, figs. 11 and 14), or as thin remains of the test fixed to the internal mould on exfoliated specimens (cf. Pl. 2, fig. 7, Pl. 9, fig. 1). It is therefore apparent that the number of lateral glabellar furrows in species of the remopleurid genera dealt with in the present paper is only a result of preservation; they all have three pairs. Similarly, the occipital tubercle seems to be present in all species in question.

The remopleurid material of the Middle Ordovician of the Oslo Region is distributed amongst six genera; Remopleurides, Remopleurella, Amphitryon, Robergia, and the two new genera Sculptella and Sculptaspis. The two latter appear somewhat lower in the succession in Norway than does the type genus of the family. The sculpture on the cranidium of these two genera is critical for specific determination. Species with a wide distribution may prove to be excellent stratigraphical guide fossils (cf. p. 277). A single
Table 1. The stratigraphic distribution of the remopleurid trilobite species discussed in this paper.

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<th>Remopleurides paucus</th>
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<td>R. affluens</td>
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<td>R. aff. affluens</td>
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<td>R. laevigatus</td>
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<td>R. perspicax</td>
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<td>R. aff. perspicax</td>
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<td>R. insitusiatns</td>
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<td>R. variolaris</td>
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<td>R. aff. variolaris</td>
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<td>R. granensis</td>
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<td>R. sp. A</td>
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<th>Scultella scripta</th>
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<td>S. aff. scripta</td>
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<td>S. scriptoides</td>
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<td>S. angustilingua</td>
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<td>S. (?) nonscripta</td>
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<tr>
<th>Sculptaspis cordata</th>
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<td>S. erratica</td>
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<td>S. insculpta</td>
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<td>S. pannucea</td>
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<td>S. impolitaa</td>
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<td>S. sexlineata</td>
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<td>S. sp.</td>
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<table>
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<th>Robergiella? sp.</th>
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<tbody>
<tr>
<td>Remopleurella burmeisteri</td>
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<tr>
<td>Amphitryon sp.</td>
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<tr>
<td>Robergia sparsa</td>
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<tr>
<td>R. microphthalmus</td>
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cranidium present may belong to a seventh genus, *Robergiella*.

Larval stages of remopleuridids are rare in the Norwegian material. Only one paraprotaspid pygidium and a few late meraspid cranidia have been found so far. However, this subject has been treated in detail by several authors, i.e. Whittington (1959), Evitt (1961), Hu (1975) and Chatterton (1980), based on silicified North American material.

**Terminology (Fig. 1)**

The terms used for the cranidium, librigena and hypostome are mainly those defined by Whittington 1959 (pp. 376–378). The glabella is used here as excluding the occipital ring. The terms *dorsal furrow* instead of axial furrow, *anterior rim* instead of anterior area of fixed cheek, and as defined by Shaw & Ormiston (1964, pp. 1001–1002) *eye socle* instead of external rim are used. The short form *posterior fixigena* has been used instead of posterior part of fixigena.

For the thoracic segments and the pygidium the terms used are mainly those defined by Harington *et al.* in Moore 1959 (pp. O117–O126), but for the reasons given by Jaanusson 1956 (pp. 36–37) the terms *axis* or *axial* are avoided. Thus in the thoracic segments the terms *rachial ring* instead of axial ring, *dorsal furrow* instead of axial furrow, and *ring furrow* instead of transverse furrow are used. Similar terms are used in the pygidium, while *postrachial ridge* replaces postaxial ridge. The term Bertillon pattern is avoided, and the term *sculptural lines* is used instead as the pattern varies considerably beyond the limits defined in the ‘Treatise’.

**Techniques**

Mechanical preparation of specimens was carried out using a dental drill and a “Burgess Vibro-tool” with mounted needles, together with fine needles and brushes. Casts were made from external moulds using silicone rubber blackened with indian ink, latex, or polyester. Specimens for photography were coated with a dilute opaque, then lightly whitened with a sublimate of ammonium chloride. The photographs have not been retouched. A fluorescent ring light was
Fig. 2. Diagrams showing the measurements used in this paper. Generally applicable measurements follow those shown by Owen (1981, text-fig. 3), based on Temple's revision (1975) of Shaw's terminology (1957). All measurements are in mm.

Measurements (Fig. 2)

Specimens were measured with the aid of an ocular micrometer graduated in 0.1 mm intervals or, in the case of large specimens, vernier calipers. Measurements obtained by doubling the width from the sagittal line are marked with an asterix. All angles are given to the nearest 5° and percentages are within the limits of ±5%, and refer merely to undistorted specimens.

Measurements were made and photographs were taken with the cranidium oriented so that the palpebral rims were horizontal. In the case of pygidia, lateral margins rested horizontally.

Repository of material

All the Norwegian material is housed in the Paleontologisk Museum, Oslo (PMO). Other cited specimens come from Sveriges geologiska undersökning, Uppsala (SGU), Paleontologiska Institutionen, Uppsala Universitet (IPU), the British Museum (Nat. Hist.), London (BM), the Peabody Museum of Natural History, Yale University, Connecticut (YPM) and the Museum of Comparative Zoology, Harvard University, Massachusetts (MCZ).

Systematic paleontology

Family REMOPLEURIDAE Hawle & Corda, 1847
Subfamily REMOPLEURIDINAE Hawle & Corda, 1847
Genus Remopleurides Portlock, 1843

Type species. – By subsequent designation of Miller, 1889 (pp. 565–566), Remopleurides Colbii Portlock, 1843, p. 256, figs. 1a–b, from the Killey Bridge Formation (Cautleyan) of Co. Tyrone, Northern Ireland.

Remarks. – The earliest appearance with certainty of the genus in the Oslo Region is the hypostome of Remopleurides sp. A (p. 261, pl. 3, fig. 11) from the Ampyx Limestone and Shale of the Ringerike district, beds which are correlated with the British graptolite zone of Nemagraptus gracilis. The hypostome is rather wide, quite unlike hypostomes found in later species in the region. It bears more similarity to early species of the British Isles, i.a. R. ateuchetos Tripp, 1979 (p. 342, pl. 37, figs. 1–6, 8) from the Llanvyrn Auchensoul Limestone of Girvan, Scotland, sug-
gesting a migration from that area in the Llandeilo. From the succeeding Lower Chasmops Shale (approximately early Caradoc) several species are present; in succession of appearance R. sp. B, R. sp. C, R. paucus n. sp., R. kulsbergen-sis Warburg, 1925, R. affluens n. sp., and R. laevigatus n. sp. Both in the British Isles and North America Remopleurides (s.s.) occurs in older beds. The genus therefore originated outside the Oslo Region. The oldest representatives, if they are Remopleurides (s.s.), seem to be a group of North American-Russian species such as R. affinis Billings, 1865, R. ligulus Whittington 1963, R. pattersoni Chatterton & Ludvigsen, 1976 and R. pisiformis Weber, 1948. This group bears strong similarities to early forms included in Robergiella from the Whiterock (=?upper Arenig-lower Llanvirn) of Spitsbergen (Fortey 1980, pp. 44–46, pl. 5, figs. 1–14, 16), strongly suggesting that Robergiella may be the ancestral genus of Remopleurides. However, these early forms differ quite distinctly from the type species of Remopleurides, i.a. in possessing a large, bulbous glabellar tongue and a very short pygidium. They may represent a separate subgenus, or, if not ancestral to Remopleurides, a separate branch in the evolution of the remopleuridids and thus a separate genus.

The earliest Remopleurides s.s. species in Norway with the cranidium known is R. paucus n. sp. (pp. 236–238, pl. 1, figs. 1–5). This species can be compared with R. jentzschi Pompecki (1890, p. 87, pl. 1, figs. 31a–b) from erratic blocks of Germany, presumably of Estonian Lasnamägi (= upper Llanvirn) origin, possibly indicating an eastern influence in the remopleuridids and thus a separate genus. Remopleurides is very common in the Caradoc strata of the Oslo region. All the well known Norwegian Middle Ordovician species are obviously closely related, strongly indicating a common origin, which most probably is to be found among species in the British Isles (Girvan district) or Baltic area. Due to the mutually close relationship, the various Norwegian species differ in only a few minor characters. The features attached importance to as distinguishing characters and mainly employed in the present work are the relative width to length of the median area and of the glabellar tongue, and the width (tr.) of the occipital furrow. Other distinguishing characters are found in the librigena and its doublure, as well as in the thoracic segments. The sculpture on the thoracic segments seems to have a fairly consistent intraspecific pattern helpful for determination (e.g. R. granensis Störmer, 1945). The sculpture on the cranidium in most species is also quite consistent, a feature previously observed in the species R. caelatus by Whittington 1959 (p. 403). Nevertheless, the pattern may vary between individuals in some species (e.g. R. variolaris n. sp., pp. 253–257, pl. 7, figs. 1–12, pl. 8, figs. 1–9).

The cranidia and pygidia of the various Norwegian species have an overall similarity and indicate a natural species group. The great differences present among Swedish, North American or Australian species are not developed (see Thorslund 1940, pl. 7, Whittington 1959, pls. 1–19 and Webby 1973, pl. 52). Equally this is also true for the hypostomes. With a few exceptions, the Norwegian species seem to be more closely related to the British species than to the Swedish-Baltic, and are clearly different from the North American, Russian or Australian forms.

Previously more than eighty species have been assigned to Remopleurides from various parts of the world. Many of the species from Europe have been inadequately described, and poorly illustrated. Furthermore, many of the remopleuridids described are based on poorly preserved material, while some species have been based on specimens found in drift boulders in the Baltic and Prussian areas, thus the exact horizons of the species are uncertain.

The pygidium figured and very briefly described by Angelin (1854, p. 84, pl. 40, fig. 20) as Lichas 4-spinus belongs without doubt to Remopleurides. The occurrence of the specimen given by Angelin is "stratisc regionis D", "Norvegia" (= Lower Ashgill). The specimen cannot be traced in either Swedish (Jaanusson, pers. comm. 1982) or Norwegian museum collections. Certainly, the pygidium figured is very similar to that of R. granensis Störmer, 1945 both in shape and ornamentation, and the stratigraphical occurrence also corresponds. However, the matter cannot be definitely solved without the original specimen, and the very best is to regard L. 4-spinus as a nomen dubium.

### Remopleurides paucus n. sp.

Pl. 1, figs. 1–5

**Name.** – From Latin paucus, few, little, referring to the rarity of the species.
Holotype. – An incomplete but relatively well preserved cranidium, PMO 74659. Coll. N. Spjeldnæs, 1951. Pl. 1, figs. 3–5.

Type stratum and type locality. – Lower Chasmops Shale, 4ba, 5–8 m below Lower Chasmops Limestone, 4bβ. Arnestadtangen in Asker, Oslo–Asker district.

Other material. – Only one fragmentary but well preserved cranidium, PMO 74658.

Diagnosis. – Median area almost three-quarters as long as wide. Glabellar tongue almost half as wide as median area, more than half as long as wide, with anterior margin distinctly concave forwards. Occipital furrow almost half as wide as median area.

Description. – Cranidium 97% as long as wide. Median area oval-shaped, quite convex transversely, 71% as long as wide, greatest width across transverse mid-line, and with extremely faint lateral glabellar furrows. S1 quite convex forwards, broad (exsag.), 30% as long as width of the median area. S2 very thin, of about equal length as S1 and very gently convex. S3 extremely faint and very short. Ornamentation on median area comprising very small, densely scattered pits and small, but distinct, nodes along the lateral margins. Glabellar tongue fairly convex (tr.), 47% as wide as median area, 54% as long as wide, parallel-sided, distinctly concave at anterior margin, and with distinct, somewhat disarranged, sculptural lines directed transversely at middle part, but laterally curving gently rearwards. Dorsal furrow deep and narrow (tr.). Palpebral furrow broad and deep anteriorly, gradually becoming shallower rearwards, and with shallow postero-lateral bend. Anterior pits very low. Anterior rim very narrow (tr.), low and slightly convex in transverse cross-section. Palpebral rim slightly convex and narrow anteriorly but flattening and widening rapidly rearwards, very gently arched down in lateral view, smooth or with very faint sculptural lines parallel to the margins. The holotype, which is about half as large as the other cranidium present, has proportionally broader palpebral rims. Occipital furrow strongly impressed, slightly concave forwards and 47% as wide as median area. Occipital ring rather convex transversely, very gently so longitudinally, and with few but distinct, forwardly convex sculptural lines. Occipital tubercle very small, located very close to occipital furrow. Posterior fixigenae of moderate width (exsag.), slightly convex both transversely and longitudinally, and dipping gently forwards.

Other parts of the trilobite unknown.

Dimensions.

<table>
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<tr>
<th>PMO 74659</th>
<th>b</th>
<th>b₁</th>
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Remarks. – R. paucus seems to have its closest relative in R. jentzschii Pompecki (1890, p. 87, pl. 1, figs. 31a–b) from erratic blocks in northern Germany, probably from Lasnamägian (= upper Llanvirn) deposits of Estonia. This species has similar proportions to R. paucus, as well as the characteristic concave anterior margin of the glabellar tongue, and may have been the ancestor of R. paucus. R. jentzschii has the palpebral rims very strongly arched down in lateral view, as opposed to the almost straight ones in R. paucus.

R. paucus also seems to be rather closely related to R. laevigatus n. sp. (pp. 243–246, pl. 3, figs. 5–10) from approximately contemporaneous beds in Ringerike. For further comments, see p. 245.

R. girvanensis Reed (1903, pp. 39–41, pl. 6, figs. 8–15) from the lower Caradoc Balclatchie Group at Girvan, Scotland, also seems to be relatively close to R. paucus but differs in having a somewhat broader and shorter glabellar tongue and distinctly more strongly depressed palpebral rims in lateral view.

The cranidium of R. sp. A of Modlinski (1973, p. 46, pl. 1, fig. 5) from the upper Llanviriin of Poland shows some resemblance to R. paucus, but seems to have a somewhat broader glabellar tongue and shorter median area.

The posterior fixigenae of R. paucus are only slightly arched down anteriorly. This character should indicate low fulcral processes, thus pointing towards later species such as R. variolaris n. sp. (pp. 253–257, pl. 7, figs. 1–12, pl. 8, figs. 1–9) from the Solvang Formation. A closer study shows the test to be very thick anteriorly and very thin posteriorly. Consequently, the internal surface is rather steep, fitting well with bulbous fulcral processes. Moreover, cranidia of R. vario-
laris, which in some specimens are strikingly similar to that of *R. paucus*, are separated by their relatively narrower glabellar tongue, shallower palpebral furrows and narrower palpebral rims posteriorly.

**Occurrence.** – As for type specimen.

*Remopleurides affluens* n. sp.

Pl. 1, figs. 6–15, pl. 2, figs. 1–5

**Name.** – From Latin *affluens*, abundant, copious, rich, profuse, referring to the abundance in some beds.


**Type stratum and type locality.** – Lower Chas­mops Limestone, 4bβ, 0.5–1.0 m above Lower Chasmops Shale, 4bβ, at Knerten, Steilene in Nesodden, Oslo–Asker district.

**Other material.** – Two fragmentary dorsal shields, one badly preserved cephalon, more than fifty more or less well preserved cranidia, six librigenae, three hypostomes, six incomplete thoraces, several detached thoracic segments, and six pygidia.

**Diagnosis.** – Median area slightly more than two-thirds as long as wide. Glabellar tongue almost half as wide as median area, more than twice as wide as long. Occipital furrow slightly more than half as wide as median area. Genal spine short, with lateral margin angular to that of librigena proper. Hypostome wider than long. Pygidium with second pair of pleural spines rather long.

**Description.** – Dorsal shield broad anteriorly, tapering gradually backwards. Cephalon (genal spines excluded) subelliptical in outline, 68% as long as wide and relatively convex. Cranidium subcircular in outline, 86% as long as wide. Median area oval, 65% as long as wide, widest just behind transverse mid-line, convex, smooth except for very small but densely spaced nodes along the lateral and postero-lateral margins. Three pairs of extremely faint lateral glabellar furrows discernible only on a few specimens as difference in colour due to thinner test. S1 moderately convex forwards, 29% as long (tr.) as the width of median area. S2 slightly convex forwards, and slightly longer than S1. S3 short, straight, and 40% as long as S1. Glabellar tongue moderately convex both transversely and longitudinally, 45% as wide as median area and 40% as long as wide, parallel-sided, with anterior margin straight or very slightly convex forwards and with a few thin but distinct sculptural lines directed transversely at the middle part, but arching strongly backwards laterally. Dorsal furrow deep and of moderate width (tr.). Palpebral furrow deep but narrow anteriorly, widening somewhat rearwards, and with a shallow postero-lateral bend. Anterior pits large but shallow. Anterior rim strongly convex (tr.) and rather narrow. Palpebral rim very narrow anteriorly but widening somewhat rearwards, usually moderately convex anteriorly and gradually flattening rearwards but moderately convex in its entire length in some specimens, about twice as broad (tr.) postero-laterally than at transverse mid-line, and only slightly depressed in lateral view. Occipital furrow narrow (sag.), strongly impressed, straight or very slightly concave forwards, and 53% as wide as median area. Occipital ring moderately convex transversely but almost flat longitudinally, and with a few thin but distinct, transverse or slightly concave, sculptural lines. Occipital tubercle very small, located close to occipital furrow. Posterior fixigena narrow (exsag.), strongly convex transversely, moderately convex longitudinally, and with anterior margin strongly bent down.

Eye large, vertical, semi-annular, broadest anteriorly, but tapering rapidly rearwards towards the base of the median area. Librigena very narrow anteriorly and laterally, its surface at transverse mid-line forming an angle of 165° with that of the eye, and provided with a short and slightly curved genal spine. The length of the genal spine is less than half the length of librigena proper and the angle with the lateral margin of librigena is 170°. Postero-lateral corner blunt but distinctly pronounced. Posterior border furrow broad (exsag.), shallow and not well defined, directed outwards and slightly backwards, and not reaching the genal notch. Eye socle large, conspicuous and strongly convex laterally, tapering rapidly both forwards and rearwards, although extending to anterior facial suture, and with very small nodes along the side close to eye socle furrow. Eye socle furrow well defined and strongly incised. Sculptural lines rather distinct, subparallel to the margins of librigena and spine. Conspicuous narrow and smooth field runs along the lateri-
al and anterior margin. Doublure of even width laterally and anteriorly. Along the median suture the doublure is gradually elevated to form a protruding but blunt point at the junction with the hypostomal suture. Hypostomal suture curves gently rearwards away from median suture to a blunt corner just behind the position of the pit. Pit located about half-way between the anterior and posterior margins. A narrow but rather distinct groove runs obliquely backwards from the pit to meet the hypostomal suture almost at the junction with the median suture. Terrace lines rather strong, parallel to the margins.

Hypostome gently convex, 80% as long as wide, with its maximum width across anterior wings. Middle body separated from border by narrow but well defined lateral and posterior border furrows, anteriorly by a broad (sag.) and very shallow furrow. Anterior margin straight at mesial part, laterally directed obliquely rearwards at an angle of 175° to axial line. Anterior wing a short blunt projection. Shoulder well pronounced. Posterolateral wing broad, with conspicuous longitudinal ridges. Middle body crescent-shaped, occupied by coalesced oval areas, which separation is indicated only by a very shallow indentation at the mid-line posteriorly, 73% as long as wide and 72% as long as length of hypostome. Sculptural lines U-shaped on the middle part of the middle body, laterally longitudinal or even oblique outwards close to the margins.

Thorax with eleven segments, the seventh segment without macropleurae, and the eighth segment bearing a very strong macrospine, which is about one and a half times as long as the width of the segment. Rachial ring about three-fifths as wide (tr.) as the complete segment, about one-third as long. First rachial ring sharply defined by strong furrows, rather narrow in the middle part but widening rapidly laterally to become more than twice as wide as at middle part. Second rachial ring made of two rounded triangular convex areas, divided from each other by a shallow and relatively broad furrow, and with both transverse, densely spaced sculptural lines and small scattered nodes. Muscle scars strongly impressed. An extremely faint postrachial ridge may be observed in some specimens. Dorsal furrow deep and narrow anteriorly, gradually becoming shallower rearwards. Fulcrum process large and rather prominent. First pleura produced into a short spine, its tip level with axial end of pygidium, pleural furrow very sharply defined, running obliquely outwards from fulcrum process to lateral margin of spine; sculptural lines run obliquely outwards outside pleural furrow, but inside are more parallel to the sagittal line. Interpleural furrow narrow but well defined, running from dorsal furrow just in front of the postero-lateral corner of first rachial ring to the inner margin of the spine of first pleura. Second pleura flattened, extended into a spine which is about half as long as the width of rachis; sculptural lines running transversely or slightly concave anteriorly but longitudinally posteriorly, and with a few small nodes close to axial line.

with sculptural lines running transversely from pleural furrow to outer margin. Pleural furrow running obliquely from the large bulbous fulcrum process to tip of pleura, sharply defined as a ridge. Posterior pleural band strongly convex posteriorly close to dorsal furrow to form the fulcrum process, strongly concave along the pleural furrow and fulcral process, giving rise to a triangular-shaped elevated field between fulcral process and fulcrum socket, and with sculptural lines parallel to those on the anterior pleural band. Dorsal furrow very deep anteriorly and posteriorly, slightly defined at middle part of each segment.

Pygidium 74% as long as wide, strongly convex both transversely and longitudinally. Articulating ring furrow very deep and rather broad (sag.), its width being 61% that of pygidium. Rachis rather prominent and bulbous, its length being 63% that of the pygidium. Articulating half ring band-like, lateral parts distinctly wider than mesial part. First rachial ring sharply defined by strong furrows, rather narrow in the middle part but widening rapidly laterally to become more than twice as wide as at middle part. Second rachial ring made of two rounded triangular convex areas, divided from each other by a shallow and relatively broad furrow, and with both transverse, densely spaced sculptural lines and small scattered nodes. Muscle scars strongly impressed. An extremely faint postrachial ridge may be observed in some specimens. Dorsal furrow deep and narrow anteriorly, gradually becoming shallower rearwards. Fulcrum process large and rather prominent. First pleura produced into a short spine, its tip level with axial end of pygidium, pleural furrow very sharply defined, running obliquely outwards from fulcrum process to lateral margin of spine; sculptural lines run obliquely outwards outside pleural furrow, but inside are more parallel to the sagittal line. Interpleural furrow narrow but well defined, running from dorsal furrow just in front of the postero-lateral corner of first rachial ring to the inner margin of the spine of first pleura. Second pleura flattened, extended into a spine which is about half as long as the width of rachis; sculptural lines running transversely or slightly concave anteriorly but longitudinally posteriorly, and with a few small nodes close to axial line.
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Remarks. – This new species is distinctive and is easily recognized by its short and broad glabellar tongue. Many species assigned to *Remopleurides* have a very broad tongue, but it is also strongly convex or even bulbous, quite unlike that of *R. affluens*. The species most similar to *R. affluens* is the considerably younger *R. latus* Olin (1906, pp. 55-56, pl. 2, figs. 5-9) from the Tretaspis Shale (lower Ashgill) of Scania in Sweden. Both have the proportions of the cranidium in common. However, *R. latus* has distinct sculptural lines on the median area, which have not been observed in any specimens of *R. affluens* in spite of the abundance and rather good preservation of the Norwegian species. The pygidium figured by Wiman (1907, pl. 8, fig. 26) as *R. latus* is distinctly broader than that of *R. affluens*.

*R. affluens* also resembles *R. girvanensis* Reed (1903, pp. 39-41, pl. 6, figs. 8-15) but differs in lacking macropleurae on the seventh thoracic segment, having palpebral rims narrower anterolaterally, a distinctly narrower pygidium, and much shorter postero-lateral projections on the hypostome.

*R. laevigatus* n. sp. (pp. 243-246, pl. 3, figs. 5-10) from the Lower Chasmops Beds in Ringerike is also similar in having a broad glabellar tongue, but is easily distinguished by its convexity of both the glabellar tongue and the median area. The librigena of *R. laevigatus* has a narrower eye socle, and the doublure close to median suture is broader (sag.) and with a smaller and shallower pit. The two species are approximately contemporaneous and obviously closely related. A possible ancestral species to both may be *R. paucus* n. sp. (236-238), pl. 1, figs. 1-5) from the Lower Chasmops Shale of the Oslo-Asker district, although the relationship with *R. affluens* seems to be more remote than to *R. laevigatus*.

The cranidium of *R. sp.* described and figured by Kier (1902, p. 13, figs. 29-30) from the Middle Ordovician of Khabarova in northern U.S.S.R. resembles *R. affluens*, but the librigena is strongly convex transversely and strongly arched down, indicating affinities to the North American members of the genus such as for instance *R. simulus* Whittington (1959, pp. 426-428, pl. 17, figs. 1-23, pl. 19, figs. 11-12) from the lower part of the Edinburg Formation of Virginia, USA.

A Russian species more similar to *R. affluens* is *R. mukatchensis* Weber (1948, p. 21, pl. 2, figs. 30-32). Judging from Weber’s illustrations of the cranidium, it seems to have a more convex glabellar tongue. The rachial rings on the thoracic segments are separated by having convex sculptural lines.

Occurrence. – The species is very common in the topmost beds of the Lower Chasmops Shale, 4b₂, and lowermost part of the Lower Chasmops Limestone, 4b₅, throughout the Oslo-Asker district. Material in the Palaeontological Museum in Oslo comes from Blakstadtangen, Bygdøy, Gås-
øya, Hovedøya, Ildjernet, Nakholmen, Nesøya, Northern Kojatangen, Østøya, Snarøya, Steilene and Vollen, all in the Oslo–Asker district.

Remopleurides aff. affluens n. sp.

Pl. 2, fig. 6


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Remarks. – The pygidium is very similar to that of *R. affluens*, but has the muscle scars located further from the dorsal furrows. The distance from rachial end to axial end is proportionally longer, and small scattered nodes are more common mesially. In beds of slightly older or possibly the same age, two species are known from the same district, i.e. *R. kullsbergensis* Warburg (1925, pp. 83–87, text-fig. 15, pl. 1, figs. 1–6) and *R. laevigatus* n. sp. (pp. 243–246, pl. 3, figs. 5–10). The two other pygidia from these beds, which are assigned herein to the first species, are immediately distinguished from *R. aff. affluens* in being considerably wider. The present pygidium may very well belong to the latter species of the two. As long as no complete dorsal shield is known of this species, the author has found it appropriate not to regard the pygidium as belonging to *R. laevigatus*.

Occurrence. – Lower Chasmops Limestone, 4bβ. Road section at Norderhov in Ringerike.

Remopleurides kullsbergensis

Warburg, 1925

Pl. 2, figs. 7–13, pl. 3, figs. 1–4

□ 1925 *Remopleurides latus* Olin var. *kullsbergensis* n. var. – Warburg, pp. 83–87, pl. 1, figs. 1–6, text-fig. 15 (Descr. and figs. of holotype, librigena and pygidium). □ 1928 *Remopleurides latus* Olin var. *kullsbergensis* E. Warb. – Kummerow, p. 7 (Recorded and short remarks). □ 1973 *Remopleurides latus kullsbergensis* Warburg, 1925 – Modlinski, p. 45, pl. 1, fig. 2 (Short descr. and fig. of cranidium).

Lectotype (here selected). – The incomplete dorsal shield figured by Warburg 1925, pl. 1, figs. 1–4, catalogue number IPU Ser. D1 no. ar 408, this paper pl. 2, figs. 7–8.

Type stratum and type locality. – Kullsberg Limestone at Kullsberg, Dalarna in Sweden.

Material. – The Norwegian material consists of four cephalan, six cranidia and two pygidia, all fairly well preserved.

Description (based on Norwegian material). – Cranidium 94 % as long as wide. Median area oval-shaped, relatively convex, 66 % as long as wide, widest across transverse mid-line, smooth except for small but densely spaced nodes along the postero-lateral and posterior margins, and with three pairs of lateral glabellar furrows, which are only discernible as slightly lighter fields due to the thinner test. S1 rather convex forwards, 22 % as long as width of median area. S2 slightly convex forwards, thin, 29 % as long as width of median area. S3 very short, straight, and 25 % as long as S2. Glabellar tongue moderately convex both longitudinally and transversely, 43 % as wide as median area, 54 % as long as wide, parallel-sided, with anterior margin straight or very gently concave, and with distinct sculptural lines running transversely at the middle part, but curving rearwards laterally. Dorsal furrow deep and broad (tr.). Palpebral furrow deep and broad anteriorly, becoming gradually narrower and shallower rearwards, and with a gentle postero-lateral bend. Anterior pits large but shallow. Anterior rim moderately convex and of moderate width (tr.). Palpebral rim gently convex, of almost even width anteriorly and laterally, postero-laterally gently increasing in width and also more flattened, its width opposite postero-lateral bend of palpebral furrow about twice that at transverse mid-line. Occipital furrow narrow (sag.), deep and straight, and about half as wide as median area. Occipital ring strongly convex transversely, very slightly convex longitudinally, with strongly serrated posterior margin, gently granulated laterally, and with a few thin, transverse sculptural lines in some specimens. Occipital tubercle very small, located close to anterior margin. Posterior fixigena narrow (exsag.), wedge-shaped, very strongly convex transversely, and with anterior margin very strongly arched down. Fulcral notch strongly impressed.
Librigena of moderate width antero-laterally, rather convex laterally, and with a relatively short genal spine, its length about one-third that of librigena proper. The angle between lateral margin of librigena and lateral margin of genal spine is 160°. Postero-lateral corner sharply defined, with genal notch strongly incised. Posterior border furrow slightly convex forwards, deep and broad (exsag.), not quite reaching genal notch. Eye socle large, conspicuous and strongly convex antero-laterally, triangular in cross-section laterally and postero-laterally, tapering rapidly forwards and rearwards, although extending to both anterior and posterior facial suture. Eye socle furrow rather broad (tr.) and deep. Sculptural lines strong, longitudinal both laterally and on genal spine. A narrow smooth field along the lateral margin is present. Doublure of even width antero-laterally and laterally, somewhat widened anteriorly where it is flattened, and strongly curved upwards laterally. The junction of the median suture and the hypostomal suture distinctly pointed. Pit located slightly closer to hypostomal suture than anterior margin. The groove from the pit to the hypostomal suture is rather prominent. Terrace lines strong, parallel to the margins.

Hypostome unknown.

The complete thorax is not known, but a specimen with three segments exists. These segments together show a marked rearward tapering in width, indicating the posterior part of the thorax. First segment with smooth and slightly depressed median area, suggesting the preceding segment to be provided with a macrospine. Thorax therefore probably consists of eleven segments as usual for genus. The following description is based on what is regarded as the ninth segment. Racial ring two-thirds as wide as complete segment, one-fifth as long as wide, strongly convex transversely, flattened and inclined forwards downwards longitudinally at mesial part, gradually becoming more convex towards lateral parts, with strong but narrow sculptural lines running somewhat irregularly transversely, and with strongly serrated posterior margin. Ring furrow somewhat convex, deep and broad (sag.), anteriorly sharply defined, posteriorly not well defined. Articulating half ring one-third as broad (sag.) as racial ring at axial line. Anterior pleural band moderately convex, with sculptural lines subparallel to lateral margin. Pleural furrow sharply defined, running obliquely from the large bulbous fulcral socket, strongly concave between this and the pleural furrow, with a finely granulated triangular field between fulcral process and fulcral socket, and with sculptural lines parallel to the posterior margin. Dorsal furrow deep anteriorly and posteriorly, shallow and slightly defined at transverse mid-line.

Pygidium 64 % as long as wide, strongly convex both transversely and longitudinally. Rachis 62 % as long as wide, 68 % as wide and 81 % as long as the pygidium. Articulating half ring gently convex (sag.), at mid-line 67 % as long as first rachial ring (sag.). Articulating ring furrow deep and narrow (sag.), its width being 56 % that of pygidium. First rachial ring sharply defined by strong furrows, rather narrow at mesial part, but widens very rapidly laterally where more than twice as wide (sag.) as at mid-line, and with strong, slightly wavy, transverse sculptural lines. Second rachial ring divided into two convex oval-shaped parts by a longitudinal shallow furrow, with transverse sculptural lines. Muscle scars rather strongly impressed. Dorsal furrow deep and narrow anteriorly, becoming rapidly shallower and broader rearwards. Fulcral process bulbous and rather prominent. First pleural strongly convex with short triangular-shaped spine, its tip reaching opposite axial end of pygidium. Pleural furrow sharply defined, directed obliquely from fulcral process to tip of first pleural spine, and with sculptural lines subparallel to margins. Interpleural furrow exposed as a low, narrow ridge running from first rachial ring at its transverse mid-line to the inner margin of first pleural spine. Second pleura convex, with rearwardly directed short spine, and with sculptural lines running transverse at the main part, longitudinally on the posterior part of the spine. The pygidium is strongly granulated all over.

Dimensions. –

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Remarks. – *R. kullsbergensis* was originally described as a subspecies of *R. latus* Olin (1906, pp. 55–56, pl. 2, figs. 5–9). Study of type material shows that there are significant differences between the two forms, especially the cranidia. The glabellar tongue is wider and much shorter, and the median area is distinctly sculptured in *R. latus*. Thus it is argued that *R. latus kullsbergensis* should be given the rank of separate species. Forms related to *R. kullsbergensis* should be looked for among species other than *R. latus* and may include *R. lunnerensis* n. sp. and *R. perspicax* n. sp. (see below p. 248 for discussion).

Other younger Norwegian species which resemble *R. kullsbergensis* are *R. privus* n. sp. (pp. 251–252, pl. 8, figs. 14–16) and *R. insitatus* n. sp. (pp. 252–253, pl. 8, figs. 11–13) from the upper part of the Solvang Formation (uppermost Caradoc) of Ringerike. Both species have a distinctly more convex median area, while the first species has a more flattened glabellar tongue, and the latter has horizontal palpebral rims in lateral view.

*R. nicholsoni* Reed (1914, pp. 12–14, pl. 2, figs. 3–9) from the Rawtheyan Starfish Bed, Drummuck Group near Girvan, Scotland, was regarded by Warburg to be closely related to *R. kullsbergensis*, but this is unlikely: The British species, which is based on parts other than the cranidium, has a pygidium with a very conspicuous post-rachial ridge, a feature characteristic of uppermost Caradoc and later species, e.g. *R. variolaris* n. sp. and *R. nikolaiseni* Owen, 1981 (see p. 256).

Among other British species, the group centred on the type species *R. colbii* Portlock (1843, p. 256, pl. 1, fig. 1) from the lower Ashgill Killey Bridge Formation of Northern Ireland is most closely related to *R. kullsbergensis*. This includes *R. laterispinifer* and *R. dorsospinifer* of Portlock 1843 (p. 256, pl. 1, figs. 2–3a), both from the same locality and strata as the type species. They both differ from *R. kullsbergensis* in having a much broader (tr.) glabellar tongue. The cranidium of *R. dorsospinifer* is strikingly like that of *R. kullsbergensis*, and although it may have a narrower glabellar tongue than *R. laterispinifer*, it is still wider than in *R. kullsbergensis*. Unfortunately the pygidia of the three species in question are not properly known. They probably have a postrachial ridge (cf. *R. cf. colbii* of Price 1980, pp. 842–843, pl. 107, figs. 4–8) and thus clearly differ from *R. kullsbergensis*.

The cranidium of *R. girvanensis* Reed (1903, pp. 39–41, pl. 6, figs. 8–15) from the approximately contemporaneous Balclatchie Group in Girvan, Scotland, also closely resembles *R. kullsbergensis* as both Warburg (1925, pp. 86–87) and Reed (1931, p. 7) have pointed out, but it seems to have a broader and more convex (tr.) glabellar tongue. The hypostome assigned to *R. girvanensis* belongs to the *eximius* group (Tripp 1967, p. 46) and thus to an Anglo-American group of species (see Tripp 1980, p. 126, text-fig. 3a–d). The Norwegian material does not contain any hypostome of similar type, nor does the Swedish material known to the author.

*R. biaculeatus* Tripp (1954, pp. 664–666, pl. 2, figs. 1–12) from upper Caradoc Craighead Mudstones near Girvan, Scotland, has some resemblance to *R. kullsbergensis*, but differs distinctly in its broader and more forwardly directed glabellar tongue.

The pygidium of *R. kullsbergensis* is also quite similar to that from the Kukruse Stage in Estonia (=Llandoilo) figured by Opik (1926, pl. 2, fig. 11 and 1937, pl. 24, fig. 2) as *R. nanus elongatus*, but can be separated by its distinctly smaller second rachial ring and shorter distance between rachial and axial end.


**Remopleurides laevigatus** n. sp.

*Pl. 3, figs. 5–10*

**Name.** – From Latin *laevigatus*, smooth, slippery, referring to the almost completely smooth median area.
Holotype. – A well preserved cranidium with three attached fragmentary thoracic segments, PMO 7359. Coll. J. Kær, 1913. Pl 3, figs. 5–6.

Type stratum and type locality. – Upper part of the Lower Chasmops Shale, 4ba. Bratterud, western side of Røysetangen, Ringerike.

Other material. – Seven cranidia and two librigenae.

Diagnosis. – Median area two-thirds as long as wide. Glabellar tongue more than half as wide as median area, more than twice as wide as long. Occipital furrow slightly more than half as wide as median area. Genal spine short, with lateral margin slightly angular to that of librigena proper.

Description. – Cranidium subcircular in outline, 92% as long as wide and rather convex. Median area relatively convex, 69% as long as wide, widest just behind transverse mid-line, smooth except for very small, densely spaced nodes along the lateral margins and some shallow wrinkles on the posterior mesial part. The three pairs of lateral glabellar furrows are only discernible through the test as difference in colour on well preserved specimens. S1 convex forwards, 30% as long as width of median area. S2 more gently convex forwards and slightly narrower than S1, 38% as long as width of median area. S3 oval, 43% as long as S1. Glabellar tongue rather convex both transversely and longitudinally, 54% as wide as median area, 41% as long as wide, parallel-sided or narrowing forwards very slightly, anterior margin straight, completely smooth except for one specimen with a few very thin sculptural lines running transversely antero-laterally and curving rearwards laterally. Dorsal furrow relatively deep and of moderate width (tr.). Palpebral furrow narrow and relatively shallow anteriorly, becoming slightly broader and shallower rearwards, and with a weakly, forwardly directed bend at the postero-lateral part. Anterior pit small and shallow. Anterior rim narrow (tr.) and strongly convex. Palpebral rim very narrow anteriorly and laterally, but gently widening rearwards, gently convex anteriorly and flattening evenly rearwards, slightly arched down in lateral view, and about three times as wide at postero-lateral part as at transverse mid-line. Occipital furrow narrow (sag.), relatively shallow, straight or very slightly convex, and 54% as wide (tr.) as median area. Occipital ring moderately convex transversely, very slightly convex longitudinally, posterior margin coarsely serrated, completely smooth except for one specimen (pl. 3, fig. 7) with shallow wrinkles on the mesial part. Occipital tubercle very small, located close to occipital furrow. Posterior fixigena short (tr.) and narrow (exsag.), moderately convex transversely, relatively convex longitudinally, and strongly arched downwards anteriorly.

Librigena extremely narrow antero-laterally but rapidly increasing in width rearwards, laterally distinctly convex and forming an angle of 170° with the surface of the eye, and with a short and gently curved genal spine. Postero-lateral corner well pronounced, almost pointed. Posterior border furrow broad (sag.) but shallow and not well defined. Eye socle large and conspicuous, broadest laterally, anteriorly gently convex, posteriorly triangular in cross-section, reaching both anterior and posterior facial suture and with very small but densely spaced wrinkles mainly concentrated on the anterior half part. Eye socle furrow very narrow anteriorly and laterally, posteriorly rather broad and deeply impressed. Sculptural lines rather coarse, subparallel to margins and spine, with a broad smooth field along lateral margin from base of genal spine to anterior facial suture. Doublure evenly widening forwards, anteriorly more abruptly widening due to the rather convex glabellar tongue, anterior part gently convex with blunt corner between median and hypostomal suture. Hypostomal suture curves very gently away from median suture to form a very blunt point opposite pit. Pit strongly impressed, located closer to hypostomal suture than anterior margin. A distinct but narrow and shallow groove extends from the pit obliquely rearwards to meet the hypostomal suture close to the junction with median suture. Terrace lines weak anteriorly, gradually becoming stronger rearwards. Hypostome unknown.

First three thoracic segments with rachial ring about two-thirds as wide as the complete segment, about one-fifth as long as wide, strongly convex transversely but very gently convex longitudinally, and with short, zig-zag-shaped, slightly concave sculptural lines. Ring furrow shallow but broad (sag.), slightly convex. Articulating half ring relatively convex (sag.), about one-third as broad (sag.) as rachial ring. Anterior pleural band moderately convex, with sculptural lines subparallel to lateral margin. Pleural furrow rather strong and well defined, directed oblique-
ly from large bulbous fulcral process to tip of pleura. Posterior pleural band strongly convex posteriorly close to dorsal furrow to form the fulcral socket, strongly concave along the pleural furrow and near fulcral process, giving rise to a triangular-shaped elevated field between fulcral process and fulcral socket, and with a few transverse sculptural lines. Dorsal furrow very deep anteriorly and posteriorly, relatively shallow at transverse mid-line.

Pygidium not known with certainty (cf. p. 241).

**Dimensions.**

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**Remarks.** – *R. laevigatus* seems to be related to *R. affluens* n. sp. (pp. 238–241, pl. 1, figs. 6–15, pl. 2, figs. 1–5) from the approximately contemporaneous transitional beds between the Lower Chasmops Shale and Lower Chasmops Limestone of the Oslo-Asker district. Both have a wide (tr.) glabellar tongue but both the median area and the glabellar tongue are much more convex in *R. laevigatus*. Possibly the two species may have an ancestral species in common, and among Norwegian species this could very well be *R. paucus* n. sp. (pp. 236–238, pl. 1, figs. 1–5) from the slightly older parts of Lower Chasmops Shale in Oslo-Asker. *R. paucus* differs in having a less convex median area and a less convex and distinctly narrower (tr.) glabellar tongue. The pygidium described herein as *R. aff. affluens* (p. 241, pl. 2, fig. 6) may belong to *R. laevigatus*, but further and more complete material is needed to clarify this. But if so, it strengthens the possibility of a close relationship between *R. affluens* and *R. laevigatus*.

*R. laevigatus* is associated with *R. kullsbergenensis* Warburg (1925, pp. 83–87, pl. 1, figs. 1–6, this paper pp. 241–243, pl. 2, figs. 7–13, pl. 3, figs. 1–4) in the Lower Chasmops Shale of Ringerike, but is easily distinguished from that species by its wide and convex glabellar tongue.

The most similar cranidium among the British species is that of *R. girvanensis* Reed (1903, pp. 39–41, pl. 6, figs. 8–15) from approximately contemporaneous beds in Girvan, Scotland. It has roughly equal proportions, but the granulation on the posterior part of the median area is not present in *R. laevigatus*.

The cranidium of *R. ateuchetos* Tripp (1979, p. 342, pl. 37, figs. 1–6, 8) from the Llanvirn-Llandeilo Auchensoul and Stinchar Limestone of Girvan also has a striking likeness to that of *R. laevigatus*. It differs from the Norwegian species only in minor characters, e.g. wider glabella and wider (tr.) occipital furrow.

The cranidium of *R. superstes* Tripp (1976, pp. 377–378, pl. 2, figs. 6–12) from the Llandeilo *superstes* Mudstones of the Girvan district, Scotland, is somewhat similar to *R. laevigatus*, but differs in having a less marked transition between median area and glabellar tongue. The hypostome of *R. laevigatus* is unknown, but hypostomes of the type found in *R. superstes* are not known in any Norwegian species. Likewise, the pygidium of *R. laevigatus* is not likely to be similar to that of *R. superstes* (cf. p. 236). The same cranidial characters noted for *R. superstes* also distinguish *R. epimera* Tripp (1980, p. 126, pl. 1, figs. 11–14) from the lower Caradoc of Girvan, from *R. laevigatus*.

*R. biaculeatus* Tripp (1954, pp. 664–666, pl. 2, figs. 1–12) from the upper Caradoc of Girvan is easily separated by its narrower glabellar tongue. This species, together with *R. procax* Tripp (1962, pp. 2–4, pl. 1, figs. 1–8) from the Llandeilo *confinis* Flags of Girvan, is also distinguished from *R. laevigatus* in having a much wider median area. *R. procax* is also strongly granulated with a less downwardly bent glabellar tongue. *R. colbii, R. dorsospinifer* and *R. longicostatus* of Portlock (1843, p. 256, pl. 1, figs. 1–3a), all from the lower Ashgill Killey Bridge Formation of Northern Ireland, differ from *R. laevigatus* in having distinctly wider librigenae and also longer genal spines. Additionally *R. dorsospinifer* has a much narrower glabellar tongue.

*R. nanus* von Leuchtenberg (1843, p. 13, pl. 1, figs. 12–13) from the Llanvirn and Llandeilo beds of the Baltic Area closely resembles *R. laevigatus*, and similarly the subspecies *R. n. elongatus* Schmidt (1894, p. 89, pl. 6, fig. 36) from the slightly younger upper Llandeilo beds.
of Estonia. Both differ in having a forwardly tapering glabellar tongue and a shorter (tr.) occipital furrow.

*R. nanus baltica* Kummerow (1928, pp. 5-6, pl. 1, figs. 2-3) from “Upper Red Orthoceras Limestone” (Llandeilo) erratic blocks of Poland differs from *R. laevigatus* in having the palpebral rims more strongly depressed in lateral view, and median area granulated in some specimens.

The cranidium from Lower Caradoc beds of northern Poland described and figured by Modlinski (1973, pp. 45-46, pl. 1, fig. 4) as *R. *wimani* is strikingly similar to that of *R. laevigatus* and can only be distinguished by its densely striated median area. Furthermore, the cranidium of *R. sp. Chugaeva* (1964, p. 28, pl. 1, figs. 10-11) from the Middle Ordovician of northeastern U.S.S.R. may resemble *R. laevigatus*, but the broader and somewhat larger glabellar tongue indicates a North American-Russian relationship.

Finally, the specimen from the Llandeilo or early Caradoc of eastern Taimyr, U.S.S.R., figured by Balashova (1960, pp. 26-27, pl. 1, figs. 4a-b) as *R. cf. salteri var. girvanensis* resembles *R. laevigatus*. Judging from the illustrations, the specimen seems to possess a rather large glabellar tongue, larger than in *R. laevigatus*. The species more probably belongs to a circumpolar species group centered around *R. affinis* (cf. p. 236).

**Remopleurides lunnerensis** n. sp.

Pl. 4, figs. 1-12

**Name.** – From Lunner community in Hadeland.


**Type stratum and type locality.** – Almost certainly upper part of the Kirkerud Group (museum material labeled 4by?). Outcrop in the small forest between Nerby and Helgehagen in Lunner, Hadeland.

**Other material.** – Eight incomplete cranidia, seven fragmentary librigenae, one small hypostome, one incomplete thorax consisting of seven segments, thirteen detached thoracic segments, and fourteen pygidia with or without attached thoracic segments.

**Diagnosis.** – Median area two-thirds as long as wide, densely granulated laterally. Glabellar tongue two-fifths as wide as median area, less than three-fifths as long as wide. Occipital furrow slightly less than half as wide as median area. Genal spine short, with lateral margin angular to that of librigena proper. Hypostome convex, as long as wide. Pygidium with second pair of pleural spines short and convex.

**Description.** – Cranidium suboval in outline, 92% as long as wide. Median area oval, 68% as long as wide, greatest width across transverse mid-line, moderately convex, smooth except for small closely spaced nodes along lateral margins (small specimens may also be granulated at the anterior part), and with three pairs of extremely shallow lateral glabellar furrows. S1 rather convex forwards, broad (sag.), 19% as long as width of median area. S2 very gently convex forwards, thin, and 27% as wide as median area. S3 very short, 18% as long as S2. Glabellar tongue moderately convex transversely, 39% as wide as median area, 57% as long as wide, parallel-sided or very slightly narrowing forwards, anterior margin slightly convex, and with thin sculptural lines running transversely at mesial anterior part, laterally strongly curving rearwards. One small specimen has the glabellar tongue strongly and densely granulated. Dorsal furrow of moderate depth and width (tr.). Palpebral furrow shallow, rather narrow and with very gentle postero-lateral bend. Anterior pit very shallow. Anterior rim of moderate width (tr.), and slightly convex. Palpebral rim narrow (tr.), slightly convex, and only slightly wider at postero-lateral corner than at transverse mid-line. Occipital furrow of moderate depth and width (sag.) and 49% as wide (tr.) as median area. Occipital ring 35% as broad (sag.) as width (tr.) of occipital furrow, strongly convex transversely and very gently so longitudinally, and with strong granulation overall, together with a few forwardly concave sculptural lines at the mesial anterior part. Occipital tubercle small but prominent. Posterior fixigena narrow (exsag.), wedge-shaped and slightly convex both transversely and longitudinally, distinctly bent downwards anteriorly.

Librigena of moderate width anteriorly and
lateral, laterally moderately convex and forming an angle of 160° with surface of the eye, and with a short and gently curved genal spine. Postero-lateral corner well pronounced, almost pointed. Posterior border furrow broad (sag.) and deep at inner part, rapidly becoming shallower outwards and fading at genal notch. Eye socle large and conspicuous, broadest laterally, anteriorly gently convex, posteriorly roughly triangular in cross-section, anteriorly almost reaching facial suture, posteriorly reaching posterior facial suture and with very small but densely spaced wrinkles close to eye socle furrow. Eye socle furrow very narrow anteriorly and laterally, posteriorly broader and deeply impressed. Sculptural lines rather coarse, subparallel to margins and spine. A broad smooth field runs along lateral margin from base of genal spine to anterior facial suture. Doublure of even width anteriorly and laterally. At the posterior part along the median suture the doublure is gradually elevated to form a protruding but blunt point at the junction with the hypostomal suture. Hypostomal suture curves gently away from median suture to a blunt point just behind the position of the pit. Pit located slightly closer to posterior margin than to anterior margin. A shallow but distinct groove runs obliquely rearwards from pit to meet the hypostomal suture almost at the junction with the median suture. Terrace lines quite strong, parallel to the margins.

Hypostome rather convex both transversely and longitudinally, about as long as wide, with maximum width across shoulders. Middle body separated from borders by narrow but distinct furrows laterally and posteriorly, anteriorly by a somewhat broader and shallower furrow. Anterior margin straight at mesial part, laterally slightly oblique rearwards, but curving forwards at tips. Anterior wing wide (sag.), wedge-shaped and quite prominent. Shoulder rounded and gently pronounced. Posterior wing broad (tr.) and strongly bent downwards. Postero-lateral projection strong and rather prominent. Posterior border wide (sag.), with its maximum width laterally and at axial line. Middle body subcircular in outline, 89% as long as wide and 73% as long as hypostome, divided by a strong median boss and a shallow longitudinal furrow. Oval area with narrow and shallow sculptural lines running longitudinal at middle and lateral parts, but curving inwards close to axial furrow.

Thorax strongly convex transversely. Two detached segments show presence of macrospine. One specimen of seven segments is lacking the spine and therefore represents the seven first segments, whilst a pygidium with three segments also lacking the macrospine strongly indicates a thorax of eleven segments, as in all other well known species of the genus. Anterior segments with rachial ring 65% as wide as the segment and about 15–20% as long as wide, with a gradual transition from the first to the eleventh segment, giving posterior segments a rachial ring which is 80% as wide as the segment and 25% as long as wide. Ring furrow deep and broad (sag.), very slightly convex. Articulating half ring gently convex (sag.), 40% as broad (sag.) as rachial ring on anterior segments, 30% on posterior segments. Fulcral process very large and bulbous. Pleura 30% as wide as rachial ring on first segment, decreasing gradually rearwards to the last segment where it is only 15% as wide as rachial ring. Anterior pleural band convex, with strong sculptural lines directed obliquely from fulcral process to tip of pleura. Posterior pleural band strongly convex posteriorly close to dorsal furrow to form the fulcral socket, with a triangular granulated elevated field between this and the fulcral process, very strongly concave along the pleural furrow, and with strong, disarranged, transverse sculptural lines. Dorsal furrow deep anteriorly and posteriorly, shallow at transverse mid-line. A distinct granulation is present on the rachial ring of all specimens.

Pygidium 70% as long as wide, strongly convex both transversely and longitudinally. Articulating half ring band-like, lateral parts distinctly wider than mesial part. Articulating ring furrow very deep and very broad (sag.), its width being 63% that of pygidium. Rachis very bulbous and prominent, its length being 90% that of pygidium. First rachial ring sharply defined by strong furrows, rather narrow at the mesial part, but widening rapidly laterally to become more than twice as broad as at axial line, distinctly granulated and with transverse, disarranged sculptural lines. Second rachial ring made of two oval and convex areas separated from each other by a shallow and broad (tr.) furrow, and with shallow, transverse but somewhat disarranged, sculptural lines, together with small nodes scattered around. Muscle scars large and strongly impressed. Postrachial ridge not present. Dorsal furrow deep and narrow anteriorly, gradually becoming shallower rearwards. Fulcral process very large and very prominent. First pleura produced into short spine with tip reaching behind.
axial end of pygidium. Pleural furrow sharply defined, directed almost straight backwards from fulcral process to tip of pleura. Sculptural lines subparallel to margins outside pleural furrow, inside this almost transverse. Interpleural furrow narrow but sharply defined, running from dorsal furrow at the transverse mid-line of first rachial ring to the inner margin of the first spine. Second pleura distinctly convex, produced into short spine, and with faint, transverse sculptural lines and small scattered nodes.

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**Remarks.** – *R. lunnerensis* is undoubtedly closely related to *R. perspicax* n. sp. (pp. 248–251, pl. 5, figs. 1–6, pl. 6, figs. 1–8) from the slightly younger or possibly contemporaneous upper part of the Solvang Formation of Ringerike and Oslo-Asker districts. The differences between the two species are small. The glabellar tongue of *R. perspicax* is slightly widening forwards as opposed to the very slightly narrowing one in *R. lunnerensis*; it is also more convex (tr.), wider, and less strongly bent down in *R. perspicax*. Furthermore, the librigena is slightly more convex laterally, and the pygidium seems to be slightly wider in *R. perspicax*. The two forms may represent only different subspecies. However, the author has preferred to treat them as separate species. The limestone block, which has produced all the present specimens of *R. lunnerensis*, is from beds slightly older than those containing *R. perspicax*. It is thus highly possible that *R. lunnerensis* is the ancestral form of the latter.

A forerunner of both *R. lunnerensis* and *R. perspicax* could be *R. kullsbergensis* Warburg (1925, pp. 83–87, pl. 1, figs. 1–6, text-fig. 15) from Lower Chasmops Beds of both Sweden and Norway. Both differ from *R. kullsbergensis* in having a less convex median area and in possessing granulation on median area, occipital ring and rachial rings of thorax.

The cranidium of *R. lunnerensis* strongly resembles that of *R. dorsospinifer* Portlock (1843, p. 256, pl. 1, figs. 3a–e) from the lower Ashgill of Northern Ireland. The librigena of *R. dorsospinifer* differs in being considerably wider laterally.

Cranidia of the British species *R. salteri* Reed (1899, pp. 747–748, pl. 49, figs. 1–3) from the somewhat earlier Tramore Limestone of Ireland (upper Llandeilo-lower Caradoc) may be quite similar to *R. lunnerensis*, but can be easily separated by their much narrower glabellar tongue. *R. salteri* is regarded by the present author as possibly belonging to the new genus *Sculptiella* (cf. pp. 266 and 276).

*R. biaculeatus* Tripp (1954, pp. 664–666, pl. 2, figs. 1–12) from the somewhat younger or contemporaneous Craighead Mudstones near Girvan, Scotland, is somewhat similar to *R. lunnerensis*, but is distinguished by its more convex median area and its wider and more convex (tr.) glabellar tongue.

**Occurrence.** – A single limestone lens almost certainly from upper part of the Kirkerud Group (museum material labeled 4by?). Hadeland: In the small forest between Nerby and Helgehagen in Lunner.

**Remopleurides perspicax** n. sp.

Pl. 5, figs. 1–6, pl. 6, figs. 1–8
Name. – From Latin *perspicax*, clear-seeing, keen, acute, referring to the large eyes of the holotype dorsal shield.


Type stratum and type locality. – Solvang Formation (= “Upper Chasmops Limestone, 4bb”), 8.0 m below Venstøp Formation. Eastern Raudskjær in Asker, Oslo-Asker district.

Other material. – Twenty-nine incomplete cranidia, three librigenae, four incomplete thoraces and five pygidia, some with attached thoracic segments.

Diagnosis. – Median area slightly more than two-thirds as long as wide. Glabellar tongue slightly less than half as wide as median area, half as long as wide. Occipital furrow less than half as wide as median area. Genal spine short, with lateral margin angular to that of librigena proper. Pygidium with posterior pleural field convex, short second pair of pleural spines.

Description. – Cephalon, excluding genal spines, oval in outline and 80% as long as wide. Median area oval, 69% as long as wide, gently convex both transversely and longitudinally, smooth or with varying sculpture, mostly densely and finely granulated at lateral parts, sometimes with openly scattered nodes all over, and also with very faint wrinkles at the antero-lateral slope. Due to the thinner test, three pairs of lateral glabellar furrows are discernible as difference in colour on well preserved specimens. S1 moderately convex forwards, broad (exsag.), 28% as long as width of median area. S2 very gently convex forward, much narrower than S1, 35% as long as width of median area, and located closer to palpebral furrow than S1. S3 short, broad (exsag.), straight, and 29% as long as S1. Glabellar tongue moderately convex transversely, 44% as wide as median area, half as long as wide, parallel-sided or slightly widening forwards, with anterior margin straight or very slightly concave, sloping obliquely downwards forwards, and with a few thin but distinct sculptural lines concave anteriorly but curving rapidly backwards laterally, one specimen also with faint but dense granulation all over. Dorsal furrow of moderate depth and width (tr.). Palpebral furrow of slightly varying depth, generally quite shallow and narrow with a shallow postero-lateral bend. Anterior pit very small and rather shallow. Anterior rim triangular in cross-section. Palpebral rim of moderate width, slightly convex anteriorly, gradually flattening rearwards, and about twice as wide postero-laterally as at transverse mid-line. Occipital furrow deep and well defined, almost straight, and 47% as wide as median area. Occipital ring 35% as long (sag.) as width of occipital furrow, flattened longitudinally, with a few concave sculptural lines at the anterior mesial part, and with distinct granulation all over. Occipital tubercle small but very distinct. Posterior fixigena narrow (exsag.), subparallel-sided, strongly convex transversely but flattened longitudinally, and with anterior margin strongly arched down.

Librigena of moderate width anteriorly and laterally, laterally quite convex and forming an angle of 130° with the surface of the eye, and with a short and relatively gently curved genal spine, its length less than one-third that of librigena proper, with lateral margin forming an angle of 160° with the lateral margin of the librigena. Eye socle large and conspicuous, broadest laterally, anteriorly gently convex, posteriorly roughly triangular in cross-section, anteriorly almost reaching facial suture, posteriorly reaching posterior facial suture, and with small but densely spaced wrinkles close to eye socle furrow. Eye socle furrow narrow and well defined anteriorly and laterally, posteriorly becoming deeper and broader. Posterior border furrow broad (exsag.) and deep at inner part, rapidly becoming shallower outwards but distinctly reaching genal notch. Sculptural lines rather coarse, subparallel to margins and spine, with a broad smooth field along lateral margin from base of genal spine to anterior facial suture. Doublure anteriorly forming an angle with the glabellar tongue of approximately 125°, rapidly flattening rearwards. Hypostomal suture curves slightly convex away from median suture to form a blunt corner opposite pit. Pit strongly impressed and located about half-way between anterior and posterior margins. The corner between median suture and hypostomal suture is distinctly pointed and rather conspicuous. A rather distinct groove runs from pit to meet the hypostomal suture almost at the junction with the median suture. Terrace lines rather strong, parallel to margins.

Hypostome unknown.

Thorax strongly convex transversely, with eleven segments, no segment bearing macro-
pleurae, the eighth segment bearing a strong macrospine, which is about as long as the width of the segment and with longitudinal list-like sculptural lines. Anterior segments with rachial ring 65% as wide as the segment, 15% as long as wide, with gradual transition rearwards to the posterior segments with rachial ring 80% as wide as the segment and 25% as long as wide. All segments with strong, wavy, transverse sculptural lines and fine, closely spaced granulation on the rachial ring. Ring furrow deep and broad (sag.), straight or very slightly convex. Articulating half ring gently convex (sag.), 40% as broad (sag.) as rachial ring on anterior segments, 30% on posterior segments. Anterior pleural band convex, leaf-like, with strong sculptural lines directed obliquely from the very large and bulbous fulcral process to tip of pleura. Posterior pleural band strongly convex posteriorly dose to dorsal furrow to form the fulcral socket, with a finely granulated triangular elevated field between fulcral socket and fulcral process, concave along the sharp and distinct pleural furrow, and with strong, transverse sculptural lines. Dorsal furrow deep anteriorly and posteriorly, shallow at transverse mid-line.

Pygidium strongly convex both transversely and longitudinally, 60% as long as wide. Rachis 75% as long as pygidium, bulbous and prominent. Articulating half ring band-like, about two-thirds as broad (sag.) as first rachial ring at axial line. Articulating ring furrow concave, very deep and broad (sag.), its width being 63% that of pygidium. First rachial ring well defined, narrow (sag.) at mesial part but rapidly widening laterally, with very strong transversely directed sculptural lines. Second rachial ring divided by longitudinal, shallow but broad furrow into two roughly triangular and slightly convex areas with transverse sculptural lines. Postrachial ridge not present. Dorsal furrow deep and well defined anteriorly, rapidly becoming shallow rearwards. Fulcral process very large and bulbous. First pleura extended into a short spine with tip reaching behind axial end of pygidium. Pleural furrow sharply defined, running backwards and slightly outwards from fulcral process to tip of pleura. Sculptural lines subparallel to margins outside pleural furrow, inside this almost transverse. Interpleural furrow narrow but sharply defined, directed obliquely backwards from dorsal furrow at the transverse mid-line of first rachial ring to the inner margin of the first spine. Second pleura distinctly convex, produced into a short spine, and with distinct, transverse sculptural lines. All parts except for first pleura outside pleural furrow, distinctly granulated.

**Dimensions.**

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**Remarks.** – The relationship to *R. lunnerensis* n. sp. has been discussed under that species (p. 248) and a comparison with the associated species, *R. variolaris* n. sp., is given below (p. 256).

The British species *R. salteri* Reed, 1899, which is regarded herein as possibly belonging to the new genus *Sculpella* (cf. pp. 266 and 276), may have somewhat similar cranidia to some specimens of *R. perspicax*, but is easily separated on the basis of its much narrower glabellar tongue.

Possibly *R. biaculeatus* Tripp (1954, pp. 664–666, pl. 2, figs. 1–12) from the upper Caradoc Craighead Mudstones near Girvan, Scotland, is
closely related to *R. perspicax*. It differs in its more convex median area and its somewhat narrower glabellar tongue. Equally, *R. dorsospinifer* Portlock (1843, p. 256, pl. 1, figs. 3a–e) seems to differ in having a somewhat narrower glabellar tongue and laterally wider librigenae.

*R. girvanensis* Reed (1903, pp. 39–41, pl. 6, figs. 8–15) from the Lower Caradoc Balclatchie Group in Girvan, Scotland, superficially resembles *R. perspicax*, but is separated by its broader (tr.) and more convex glabellar tongue, in possessing macropleurae on the seventh thoracic segment, and in its shorter pygidium.

**Occurrence.** – Oslo–Asker: The species occurs most commonly somewhat below the top of the Solvang Formation (= “Upper Chasmops Limestone, 4bδ”) in the western localities, in the eastern localities it is the common species in the topmost beds. At Raudskjær and Terneholmen in the Askø area the species has been found from 8 to 2 m below the Venstøp Formation. Other localities in the district are Bjerkøya, Bygdøy, Landsteilen, Nakholmen, Persteilen and Snarøya.

Ringerike: The species seems to be common in the Norderhov Formation (material in the collections labelled Upper Chasmops Shale). Brat­terud, Frok, Norderhov, Rud and Vestbråten.

**Remopleurides aff. perspicax** n. sp.

Pl. 6, figs. 12–14

**Material.** – Two fragmentary cranidia, PMO 5392 and PMO 5899.

**Dimensions.** –

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**Remarks.** – The two cranidia are rather similar to some other cranidia included in *R. perspicax*, especially PMO 74720 (pl. 5, fig. 6). This specimen is from the so-called Illaenus-bed at Terneholmen, which is 7 m below the top of the Solvang Formation. As shown by Bruton and Owen 1979, this stratigraphical level is found in the top of the Solvang Formation further east in the Oslo–Asker district where the two cranidia are from. However, the two cranidia differ from *R. perspicax* in having a much more convex and much wider glabellar tongue.

The dense and rather coarse granulation on the median area of *R. aff. perspicax* recalls the cranidium of the somewhat younger *R. sp. H* (pp. 264–265, pl. 9, figs. 5–7) from the Høgberg Member of the Solvang Formation in Ringerike, but differs from this in having a much wider (tr.) occipital furrow and distinctly narrower (exsag.) S1.

Granulated cranidia very similar to that of *R. aff. perspicax* are reported from both the British Isles and North America, i.e. *R. sp. Dean* (1971, pp. 16–17, pl. 6 and 9, figs. 6 and 9a) from the Llandeilo age of New World Island, northeastern Newfoundland, *R. tuberculatus* Reed (1899, p. 748, pl. 49, fig. 5) from the lower Caradoc of Ireland, and *R. sp. ind. (a) Nicholson & Etheridge* (1880, pp. 149–150, pl. 10, figs. 9–9a) from the Ashgill Drummuck Group of Girvan, Scotland. *R. tuberculatus* differs from *R. aff. perspicax* in having a narrower glabellar tongue, whereas the others are too fragmentary or poorly preserved to allow any close comparison.

**Occurrence.** – Uppermost limestone bed in the Solvang Formation (= “Upper Chasmops Limestone, 4bδ”). Oslo–Asker: Rambergøya in Oslo and Southern Skjærholmen in Nesodden.

**Remopleurides privus** n. sp.

Pl. 8, figs. 14–16

**Name.** – From Latin *privus*, alone, each, single, on the grounds that only one specimen is present.

**Holotype.** – An almost complete and well preserved cranidium, PMO 75059. Coll. Excursion, 1960. Pl. 8, figs. 14–16.

**Type stratum and type locality.** – Upper part of the Solvang Formation. Road section at Norder­hov, Ringerike.

**Other material.** – The holotype is the only specimen known.
Diagnosis. – Median area almost two-thirds as long as wide. Glabellar tongue two-fifths as wide as median area, almost three-fifths as long as wide. Palpebral rim strongly depressed in lateral view. Occipital furrow somewhat more than half as wide as median area.

Description. – Cranidium 86% as long as wide. Median area fairly convex both transversely and longitudinally, 64% as long as wide, widest across transverse mid-line, smooth. The three pairs of lateral glabellar 'furrows' are discernible as extremely faintly elevated ridges on the test, but also as different coloured stripes. S1 very strongly convex forwards, almost angulated so that inner part is subparallel to axial line, length from tip to tip 27% the width of median area. S2 gently convex forwards, distinctly narrower (sag.) than S1, 30% as long as median area. S3 short, straight and 23% as long as S2. Glabellar tongue gently convex transversely, 40% as wide as median area, 56% as long as wide, parallel-sided, with anterior margin distinctly convex, and with a very few very thin sculptural lines running transversely at mesial part, laterally curving strongly rearwards. Dorsal furrow shallow and quite broad for the genus. Palpebral furrow deep, sharply defined, and with postero-lateral bend rather shallow. Anterior pit small but distinct. Anterior rim narrow (tr.) and gently convex. Palpebral rim rather narrow, very slightly convex, distinctly depressed in lateral view. Occipital furrow very narrow (sag.), deeply impressed and 54% as wide as median area. Occipital ring strongly convex transversely, very gently convex longitudinally, smooth, posterior margin smooth mesially but bearing tooth-like nodes of increasing size towards the fulcral notches. Occipital tubercle very small. Posterior fixigenae narrow (exsag.), short, moderately convex transversely, very gently convex longitudinally, and with anterior margin strongly arched downwards forwards.

Occurrence. – As for type specimen.

Remopleurides inusitatus n. sp.
Pl. 8, figs. 11–13

Name. – From Latin inusitatus, rare, uncommon, referring to the single specimen present.

Holotype. – A large almost complete and well preserved cranidium, PMO 9119. Coll. J. Kiær, 1914. Pl. 8, figs. 11–13.
Type stratum and type locality. – Høgberg Member of the Solvang Formation. Western side of Frognøya, Lake Tyrifjorden, Ringerike.

Other material. – The holotype is the only specimen known.

Diagnosis. – Median area two-thirds as long as wide. Glabellar tongue about two-fifths as wide as median area, almost half as long as wide. Palpebral rim straight in lateral view. Occipital furrow more than half as wide as median area.

Description. – Cranidium 81% as long as wide. Median area oval, 65% as long as wide, widest across transverse mid-line, rather convex both transversely and longitudinally, with highest point just behind frontal slope, completely smooth except for small wrinkles along lateral edges. The three pairs of lateral glabellar furrows are discernible as very faint elevated stripes and by difference in colour. S1 strongly convex forwards, broad (exsag.) and 27% as long as width of median area. S2 very gently convex forwards, narrow and 33% as long as width of median area. S3 short, 30% as long as S1. Glabellar tongue moderately convex (tr.), 42% as wide as median area, 46% as long as wide, parallel-sided, with anterior margin slightly convex, and with a few thin sculptural lines running transversely anteriorly, laterally curving rearwards. Dorsal furrow of moderate depth and width (tr.). Palpebral furrow shallow, with well defined postero-lateral bend. Anterior rim very narrow (tr.) and strongly convex. Palpebral rim narrow, very gently convex anteriorly as well as posteriorly, and very nearly straight in lateral view. Occipital furrow narrow (sag.) mesially, laterally deep and broad, almost straight and 53% as wide as width of median area. Occipital ring slightly less convex transversely than usual for the genus, almost flattened longitudinally, 30% as broad (sag.) as width of median area, and smooth except for very shallow longitudinal wrinkles. Occipital tubercle small. Posterior fixigena short (tr.), moderately convex transversely, longitudinally flattened and with anterior margin arched down.

Other parts of the trilobite unknown.

Dimensions. –

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Remarks. – Only the holotype cranidium is known of this species, but as the specimen is remarkably well preserved, the author has found it justifiable to name the trilobite.

The species is easily separated from the other similar species by its straight palpebral rims in lateral view. The low transverse convexity of the posterior fixigenae indicates low fulcral processes on the thoracic segments as found in the contemporaneous or slightly older and more fully known R. variolaris n. sp. (pp. 253–257, pl. 7, figs. 1–12, pl. 8, figs. 1–9) from the uppermost part of the Solvang Formation in the Oslo–Asker district. The latter species is easily distinguished from R. inusitatus by its less convex median area as well as the character mentioned above.

In particular R. inusitatus recalls R. privus n. sp. (pp. 251–252, pl. 8, figs. 14–16), a species also occurring in the upper part of the Solvang Formation in Ringerike. This monotype species differs distinctly in its less convex median area and narrower, somewhat less convex glabellar tongue, as well as in its depressed palpebral rims in lateral view.

R. inusitatus may also be compared with R. tumidus Ruedemann (1901, pp. 54–55, pl. 4, figs. 2–4) from the presumed somewhat older “Trenton Group” of New York, U.S.A., which only differs in having a somewhat more convex median area and shorter occipital furrow.

Occurrence. – As for type specimen.

Remopleurides variolaris n. sp.

Pl. 7, figs. 1–12, pl. 8, figs. 1–9

□?1887 Remopleurides – Brøgger, p. 23 (Recorded). □Remopleurides sp. nov. A – Bruton & Owen, p. 216 (partim.) (Recorded). □1981 Remopleurides n. sp. – Owen, p. 16, pl. 3, figs. 8–9 (Recorded and figs. of cranidium and hypostome).

Name. – From Latin varius, different, referring to the varying sculpture on the median area.

Holotype. – A complete but mostly exfoliated dorsal shield, PMO 5598. Coll. Excursion, 1922. Pl. 7, figs. 1–2.
Type stratum and type locality. – Solvang Formation (= "Upper Chasmops Limestone, 4bø"), approximately 2 m below Venstøp Formation. Terneholmen in Asker, Oslo-Asker district.

Other material. – Several fragments and detached parts of all parts of the dorsal shield.

Diagnosis. – Median area almost two-thirds as long as wide. Glabellar tongue almost half as wide as median area, about half as long as wide. Occipital furrow half as wide as median area. Posterior fixigena gently convex transversely. Genal spine very long, with lateral margin even with that of librigena proper. Hypostome almost as long as wide. Thoracic segments with low fulcral processes and gently convex pleurae. Pygidium with postrachial ridge, second pair of pleural spines long and flattened.

Description. – Cranidium 92% as long as wide. Median area oval-shaped, 65% as long as wide, moderately convex, widest slightly behind transverse mid-line, and with varying sculpture. Most specimens smooth except for very faint sculptural lines laterally and posteriorly. However some specimens with rather distinct, concave sculptural lines (pl. 8, figs. 3 and 5), others with faint pits, and others with strong granulation along the lateral edges. The three pairs of lateral glabellar 'furrows' are discernible as extremely faintly elevated ridges or as smooth fields in sculptured specimens. S1 rather convex forwards, broad (exsag.) and 27% as long as width of median area. S2 very slightly convex forwards, very thin, extending almost to lateral margin and 32% as long as width of median area. S3 broader (exsag.) than S2 and 25% as long as this. Glabellar tongue rather convex transversely, 48% as wide as median area, 50% as long as wide, parallel-sided with anterior margin concave rearwards, and with few, thin sculptural lines running transversely mesially, but curving rearwards laterally. Dorsal furrow narrow (tr.) and shallow. Palpebral furrow shallow but sharply defined, with a well pronounced postero-lateral bend. Anterior pit very small and shallow. Anterior rim very narrow (tr.) and gently convex. Palpebral rim of moderate width antero-laterally, slightly convex anteriorly, flattening rearwards, about twice as wide posteriorly as at transverse mid-line, and gently arched down in lateral view. Occipital furrow shallow but sharply defined, straight or slightly wavy, and half as wide as median area. Occipital ring 17% as broad (sag.) as width of median area, moderately convex transversely, rather flattened longitudinally, and with strong, wavy, convex sculptural lines. Occipital tubercle very small but distinct. Posterior fixigena gently convex transversely, flattened longitudinally and with anterior margin gently arched downwards. Librigena of moderate width anteriorly and laterally, laterally gently convex and forming an angle of 155° with the surface of the eye. Genal spine almost equally long as librigena proper, gently curved, transversely gently convex but almost flat along outer margin, with strong subparallel sculptural lines, and with outer margin forming an almost straight line with that of librigena proper. Genal notch narrow (tr.) but rather strongly incised, giving rise to a distinctly pointed postero-lateral corner. Posterior border furrow broad (exsag.), shallow and not sharply defined, running from posterior facial suture outwards and slightly forwards in front of genal notch. Eye socle furrow very shallow anteriorly, gradually becoming somewhat deeper rearwards. Sculptural lines strong and subparallel to margins; a narrow field along lateral margin shows extremely fine longitudinal lines. Doublure anteriorly forming an angle with the glabellar tongue of approximately 110°, but rapidly flattening laterally, and strongly curved upwards at lateral and postero-lateral parts. Hypostomal suture curves gently away from median suture to form a blunt point just behind the pits. At posterior end of median suture the doublure forms a blunt point. Pit very strongly impressed, located slightly closer to anterior margin than posterior. The groove from pit to anterior end of hypostomal suture is narrow and shallow. Terrace lines very strong, parallel to margins.

Hypostome gently convex, 91% as long as wide, with maximum width across anterior wings. Middle body separated from borders by narrow but distinct furrows laterally and posteriorly; anteriorly by a somewhat broader, shallow furrow. Anterior margin straight at mesial part, laterally slightly oblique rearwards but curving forwards at ends. Anterior wing wide (tr.), wedge-shaped and quite prominent. Shoulder gently pronounced. Posterior wing very strongly curved longitudinally, broad and arched steeply down. Postero-lateral projections strong and
rather pointed. Posterior border furrow broad (sag.), with its maximum width laterally, and provided with very small nodes especially concentrated at lateral parts. Middle body subcircular, 73% as long as hypostome, divided by a strong median boss and a shallow longitudinal furrow into two oval areas. Oval area very gently impressed, sculptural lines running longitudinally at middle part, but curving towards lateral margins close to these.

Thorax moderately convex transversely, with eleven segments as is usual for the genus, no segment with macropleurae, but one less well preserved thorax (PMO 75 000) includes one segment, in all probability the eight, with a strong macrospine. Anterior segments with rachial ring two-thirds as wide as the segment, one-third as long as wide, posterior segments with rachial ring two-fifths as wide as the segment and one-fifth as long as wide, with a rapid transition in the posterior half part of the thorax, and with strong, wavy, transverse sculptural lines. Ring furrow broad (sag.), of moderate depth and slightly convex. Articulating half ring very gently convex longitudinally, narrow at mesial part but very broad laterally. Pleurae gently convex in anterior segments; almost flattened in posterior segments. Fulcral process rather low. Anterior pleural band very gently convex, produced into distinct but short spine, and with narrow sculptural lines directed obliquely outwards. Pleural furrow narrow but well defined. Posterior pleural band convex posteriorly close to dorsal furrow to form the low fulcral socket, with a triangular, smooth, elevated field between this and the fulcral process, gently concave along the pleural furrow, and with sculptural lines parallel to those on anterior pleural band. Dorsal furrow shallow.

Pygidium 61% as long as wide, moderately convex transversely and very gently convex longitudinally. Rachis 54% as long as pygidium, moderately convex both transversely and longitudinally. Articulating half ring very narrow mesially, laterally more than twice as broad. Articulating ring furrow narrow (sag.) and shallow, 53% as wide as pygidium. First rachial ring separated from second by a shallow but remarkably broad (sag.) and well defined furrow, very narrow at axial line, expanding laterally to become almost three times as broad, and with transverse sculptural lines. Second rachial ring divided into two roughly triangular areas by a shallow and broad longitudinal furrow, which also divides the first rachial ring on internal moulds. Second rachial ring also with wavy, transverse sculptural lines and a few nodes close to axial line. Muscle scars shallow. Postrachial ridge distinct and bearing a few small nodes. Fulcral process small but extended. First pleura very gently convex, extended into short spine of which tip is quite far behind axial end of pygidium. Pleural furrow narrow and very sharply defined, very slightly sinusous, and directed rearwards and slightly outwards from a point opposite transverse mid-line of first rachial ring to the lateral margin of first spine close to its tip. Interpleural furrow only indicated by the interruption of the sculptural lines, which are longitudinal on the outside and transverse on the inside of this. Second pleura almost flat, produced into a wedge-shaped spine with distinctly concavely running sculptural lines.

Meraspid stages. – Three meraspid cranidia of this species are present in the collections. They all agree very well with the material described by Whittington (1959) and later redescribed by Hu (1975). The smallest cranidium is very similar to the postdegree 0 stage figured by Whittington (pl. 3, fig. 16) and the two largest resemble his late meraspid cranidia (ibid., pl. 4, figs. 1–2) as well as those cranidia figured by Hu (1975, pl. 2, figs. 14–17). Little can be added to the knowledge of the ontogeny of Remopleurides on basis of the present material. The lateral glabellar furrows, which are faintly defined in Whittington’s and Hu’s material, are rather distinct. In the smallest cranidium (pl. 8, fig. 5) the distance between S3 and S2 is considerably longer than that between S2 and S1, a character rapidly adjusted in the somewhat larger cranidia of late meraspid stage.

Dimensions. –

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Remarks. – With its distinct postrachial ridge, this species approaches the Ashgill species group centered around *R. colbii*. The postrachial ridge seems to be a very characteristic feature of the British and Norwegian species in the very late Caradoc and Ashgill. It is found in *R. colbii* Portlock, 1843, *R. dorsospinifer* Portlock, 1843, *R. nicholsoni* Reed, 1914, *R*. sp. B? Ingham (1970, pl. 1, fig. 20), *R*. sp. Cocks & Price (1975, pl. 81, fig. 5), *R. granensis* Størmer, 1945, *R. nikolaiseni* Owen, 1981, and in the pygidium figured by Wiman (1907, pl. 8, fig. 26) as *R. latus*. A distinct postrachial ridge is also present in the pygidium of the eastern Canadian species *R. striatus* Cooper & Kindle, 1936, the objective senior synonym of *R. sinclairi* Cooper & Kindle, 1947. This upper Ordovician species is probably related to the Swedish species *R. latifrons* Warburg, 1925. The ontogeny of the North American species *R. caelatus* Whittington, 1959, known from silicified material from Virginia, was redescribed by Hu 1975. He considered the presence or absence of a postrachial ridge to reflect sexual dimorphism. This may be the case concerning that species, which is of early Caradoc age. *R. variolaris* is associated with *R. perspicax* n. sp. (pp. 248–251, pl. 5, figs. 1–6, pl. 6, figs. 1–8) in the upper part of the Solvang Formation in the western part of the Oslo–Asker district, a species with a pygidium with a short, convex posterior pleural field and without a postrachial ridge. However, *R. perspicax* appears earlier in the succession than *R. variolaris*. In the eastern part of the district, only *R. variolaris* continues into the overlying Venstøp Formation, which in its lower part is chronostratigraphically equivalent to the upper part of the Solvang Formation in the western part. Although the two species are roughly contemporaneous, *R. variolaris* has its greatest abundance later than *R. perspicax*. The cranidium of *R. variolaris* is almost indistinguishable from that of *R. perspicax*. It may be separated in lacking granulation on the median area and occipital ring, and by its more convex (tr.) and more vertical glabellar tongue. Conversely, the librigena is easily separated by being much less convex laterally, in having the posterior border furrow running in front of genal notch, and in its even lateral margin from librigena proper to genal spine. The pleurae on the thoracic segments are much more flattened, with distinctly lower fulcral processes and more pointed spines. In fact the differences are so marked that a single thoracic segment is enough to determine the species. Likewise, the pleural field in the posterior part of the pygidium of *R. variolaris* is almost flat, as opposed to that of *R. perspicax* (see also *R. aff. variolaris*, p. 258).

The cranidium of *R. variolaris* is rather similar to that of *R. colbii*, but is separated from this by its narrower glabellar tongue, which also seems to be more convex (tr.) and less steeply inclined in *R. variolaris*. The hypostome

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\text{PMO 82105} & 8.4 & 10.2 & 1.7 & 12.2 & 11.2 & 5.7 & 7.0 & 2.2 & 4.7 \\
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\text{PMO 74759} & 4.1 & 4.9 & 4.1 & 2.9 & 4.4 \\
\text{PMO 82102} & 2.4 & 2.4 & 2.0 & 1.7 & - \\
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\text{w} & x & y & z & z_1 & z_2 \\
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\text{PMO 5475} & 2.7 & 1.6 & 1.1 & 1.6 & 1.9 & 2.7 \\
\text{PMO 16090} & 1.1 & 0.8 & 0.5 & 0.8 & 0.9 & 1.2 \\
\text{PMO 74758} & 2.1 & 1.3 & 0.9 & 1.5 & 1.8 & 2.2 \\
\text{PMO 95765} & 6.0 & 3.6 & 2.0 & 3.8 & 4.3 & 5.6 \\
\end{array}
$$
illustrated by Portlock (1843, pl. 24, fig. 10, Whittington 1950, pl. 70, fig. 2) is considerably wider than that of *R. variolaris*, but this is at least exaggerated by crushing. On the basis of the similarities mentioned above, there should be no doubt that the two species are closely related, which is reinforced by their approximately contemporaneous existence.

The material from the Cautleyan-Rawtheyan Shoeshook Limestone Formation of South Wales described by Price (1980, pp. 842–843, pl. 107, figs. 4–8) as *R. cf. colbii* agrees well with the material of the Norwegian *R. variolaris*. However, the glabellar tongue of *R. variolaris* is somewhat narrower as is the occipital furrow (tr.). Compared to the pygidium in *R. variolaris*, that of *R. cf. colbii* seems to be considerably longer, probably due to preservation.

*R. sp. B?* of Ingham (1970, p. 13, pl. figs. 20–21) from Cautleyan beds of England is probably related to *R. variolaris* as well as to the other British species mentioned above. A faint postpacial ridge is present in the pygidium, and the pattern of the sculptural lines on the librigena figured agrees very well.

*R. craigensis* Reed (1935, pp. 20–11, pl. 1, figs. 18–18a) from the upper Caradoc Craighead Limestone of Girvan, Scotland, also may be related to *R. variolaris*. It has a sculpture on the median area somewhat similar to that found in some specimens of *R. variolaris* (cf. pl. 8, figs. 3 and 5), but according to Reed’s descriptions, the sculpture is more concentric than in *R. variolaris*. The palpebral rim is very strongly arched down in lateral view in *R. craigensis*, a character clearly separating it from *R. variolaris*.

Two species previously described from Norway seem to be related to *R. variolaris*, i.e. *R. granensis* Størmer (1945, p. 408, pl. 4, fig. 4) from the Gagnum Shale Member of the Lunner Formation in Hadeland, and *R. nikolaiseni* Owen (1981, pp. 15–16, pl. 2, figs. 15–22, pl. 3, figs. 5–18). In his monograph of the Ashgill trilobites of the Oslo Region, Owen (1981, pp. 12–13, pl. 1, figs. 5–18) redescribed the holotype of *R. granensis* together with supplementary material. The pygidium he figured is an internal mould and does not show the postpacial ridge distinctly (cf. p. 260). The cranidium of *R. granensis* is rather similar to that of *R. variolaris*, but has a more convex median area and a less convex glabellar tongue. The thorax and the pygidium is easily separated by being coarsely and densely granulated, whereas nodes are scarce in the pygidium of *R. variolaris*. The cranidium of the upper Ashgill species *R. nikolaiseni* is rather similar to that of *R. variolaris*, but is separated by its more convex median area and wider tongue. The librigena is distinguished in being much narrower laterally with the posterior border furrow reaching genal notch. Two excellently preserved specimens of pygidia with ten and six attached thoracic segments respectively not seen by Owen allow close comparison with *R. variolaris*. The pleurae on the thoracic segments are distinctly more convex than in *R. variolaris*. The pygidium is very much like that of *R. variolaris*, and differs only in being slightly more granulated.

*R. privus* n. sp. (pp. 251–252, pl. 8, figs. 14–16) is from approximately contemporaneous deposits of the Ringerike district. This species, which is only known from one specimen, has a low transverse convexity of the posterior fixigenae, indicating low fulcral processes on the thoracic segments as in *R. variolaris*. However, it differs distinctly by its narrower, much more flattened glabellar tongue and considerably wider (tr.) occipital furrow.

*R. inusitatus* n. sp. (pp. 252–253, pl. 8, figs. 11–13) from the Høgberg Member of the Solvang Formation in Ringerike is easily separated by its much more convex median area and in having the palpebral rims not depressed in lateral view.

*R. sp. of Asklund* (1936, p. 6, pl. 1, fig. 7) from Lower Ashgill Tretaspis Beds of Jämtland, Sweden, also resembles *R. variolaris*, but differs in having narrower glabellar tongue and shorter (tr.) occipital furrow. The material of Linnarsson (1869, pp. 68–69, pl. 1, figs. 23–25) from “Trinucleidskiffer” (= Lower Ashgill) of Sweden described as *R. dorsospinifer*, also resembles that of *R. variolaris*. Unfortunately the author has not had the opportunity of examining this material, but judging from Linnarsson’s description, this material agrees quite well with the material of *R. variolaris*.

**Remopleurides aff. variolaris** n. sp.

Pl. 8, fig. 10


**Dimensions.** –

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**Remarks.** – This specimen seems to occupy an intermediate position between *R. perspicax* n. sp. (pp. 248–251, pl. 5, figs. 1–6, pl. 6, figs. 1–8) and *R. variolaris* n. sp. In all respects the characters are intermediate. The pleuræ of the thoracic segments are moderately convex, with the posterior pleural band only gently concave along the pleural furrow and distinctly broader (exsag.) than in *R. variolaris*. The fulcral processes are more bulbous and overhanging the pleurae almost like in *R. perspicax*, and the tip of the pleura is less pointed than in *R. variolaris*. The pygidium has a sculpture equal to that of *R. variolaris*, but has a convex pleural area like that of *R. perspicax*. A distinct postrachial ridge is not present. The second pair of spines are distinctly upwardly curved (sag.), but flattened (tr.) as in *R. variolaris*. Granulation recalls that of *R. perspicax*, and although the pygidium is broader than that of *R. variolaris*, the proportions are closer to those of this species than to those of *R. perspicax*. The specimen is from a limestone layer often referred to as the “Illaenus-bed”, a horizon recognized in the middle and western parts of the Oslo-Asker district. At Eastern Raudskjær in the western part of the district, the “Illaenus-bed” occurs about 7 m below the Venstep Formation. At this locality *R. perspicax* is the common species at this level, in terms of pygidia, whereas *R. variolaris* by far outnumbers *R. perspicax* at the higher levels. As pointed out above, cranidia of the two species in question are virtually indistinguishable. It is possible that some cranidia included in *R. variolaris* may prove not to belong to this, or *R. perspicax* for that matter. Consequently, the present specimen may represent a separate species. Further and more complete material is needed to clarify this. Possibly, a gradual evolution from *R. perspicax* into *R. variolaris* may have taken place. If this is the case, it means that the British species group around *R. colbii*, which undoubtedly is related to *R. variolaris*, may have its ancestors in the Oslo Region. Probably *R. variolaris* is slightly older than *R. colbii* from basal Cautleyan Killey Bridge Formation in Northern Ireland.

A migration from the Oslo Region to the British Isles therefore seems possible and not in the opposite direction as often suggested (cf. Bruton & Owen 1979, pp. 220–221).


**Remopleurides granensis** Størmer, 1945

Pl. 9, figs. 1–4

□ 1945 *Remopleurides latus* Olin var. *granensis* n. var. – Størmer, p. 408, pl. 4, fig. 4 (Descr. and fig. of holotype) □ 1953 *Remopleurides* sp. – Størmer, p. 94 (Recorded). □ 1981 *Remopleurides granensis* Størmer, 1945 – Owen, pp. 12–13, pl. 1, figs. 5–18 (?non figs. 8, 10) (Descr. and figs. of holotype, cranidia, librigena, thorax and pygidium).

**Holotype.** – A fragmentary cranidium, PMO 65082a. Coll. J. Dons, 1944. Pl. 9, figs. 1–2.

**Type stratum and type locality.** – Gagnum Shale Member of the Lunner Formation. North-east shore of Rokotjernet, Hadeland.

**Other material.** – Two fragmentary dorsal shields, four fragmentary cranidia, three librigenae, one thoracic segment with macrospine, and two pygidia, most of which are not well preserved.

**Diagnosis.** – Median area almost two-thirds as long as wide. Glabellar tongue more than two-fifths as wide as median area, half as long as wide. Occipital furrow half as wide as median area. Genal spine long, with lateral margin gently angular to that of librigena proper. Thoracic segments with anterior pleural band granulated. Pygidium strongly granulated, with postrachial ridge.

**Description.** – Cranidium 94% as long as wide. Median area oval, 62% as long as wide, its convexity due to steep lateral margins, and with fine
and dense granulation especially concentrated to the lateral parts. Three pairs of lateral glabellar furrows present as differences in colour or fixed to the internal mould on exfoliated specimens. S1 convex forwards, 20% as long as width of median area. S2 gently convex forwards, 29% as long as width of median area. S3 short, 21% as long as S2. Glabellar tongue moderately convex transversely, 43% as wide as median area, half as long as wide, parallel-sided, with anterior margin straight or very slightly convex, and especially in smaller specimens densely covered with small nodes; in the holotype also small pits all over. Dorsal furrow deep and broad (tr.). Palpebral furrow deep, with shallowly incised postero-lateral bend. Anterior rim narrow (tr.) and strongly convex. Palpebral rim of moderate width, anteriorly triangular in cross-section, but rapidly flattening rearwards. Occipital furrow deep and broad (sag.), half as wide as median area. Occipital ring strongly convex transversely, gently convex longitudinally, and with more or less strong granulation. Occipital tubercle strong and prominent. Posterior fixigena strongly convex transversely, convex longitudinally, and with anterior margin very strongly inclined.

Librigena of moderate width anteriorly and laterally, laterally moderately convex and forming an angle with the surface of the eye of approximately 120°, and with a long and gently curved genal spine, its length being almost equal to that of librigena proper. Lateral margin of genal spine forming an almost straight line with the lateral margin of the librigena. Eye socle very large and conspicuous, broadest laterally, anteriorly gently convex and not reaching facial suture, posteriorly roughly triangular in cross-section and reaching facial suture. Eye socle furrow narrow and well defined anteriorly and laterally, posteriorly becoming rapidly broader and deeper. Posterior border furrow very deep, parallel to posterior margin and reaching the large and deeply incised genal notch. Lateral and posterior part of librigena with closely spaced small pits, genal spine with longitudinal sculptural lines. Anterior part of doublure almost bulbous, forming an angle with the glabellar tongue of almost 180° at the median suture. Pit strongly impressed, with distinct groove from this to the junction between median and hypostomal suture.

Hypostome unknown.

Thorax with eleven segments, no segment with macropleurae, but eighth segment bears a strong and very long macrospine. Rachial ring very strongly granulated, coarsely serrated posterolaterally. Pleura strongly granulated on the anterior pleural band, an unusual character only faintly found in the later species *R. nikolaiseni* Owen, 1981. Anterior pleural band also with a distinct flange laterally. Fulcral process and fulcral socket very large and bulbous.

Pygidium strongly convex transversely, 65% as long as wide. Rachis bulbous and prominent, 65% as long as pygidium. Articulating ring furrow convex, deep and narrow, its width being 63% that of pygidium. First rachial ring separated from second rachial ring by a shallow but remarkably broad (sag.) and well defined furrow, narrow at axial line, expanding rapidly laterally. Second rachial ring divided into two oval-shaped, slightly convex areas by a shallow longitudinal furrow, which also divides the first rachial ring on internal moulds. Muscle scar very strongly impressed. Postrachial ridge very distinct. Dorsal furrow shallow. Fulcral process very large and extended. First pleura gently convex, produced into a short spine; tip reaches quite far behind axial end of pygidium. Pleural furrow sharply defined, curving obliquely rearwards from fulcral process to tip of pleura. Interpleural furrow very sharply defined, straight, running rearwards and slightly outwards from dorsal furrow at the transverse mid-line of first rachial ring to the inner margin of the first spine. Second pleura very gently convex, produced into a short and slightly upwardly curved spine. All parts of the pygidium with rather coarse and dense granulation, pleura outside pleural furrow also with a few sculptural lines subparallel to the lateral margin.

*Dimensions.*

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*Middle Ordovician trilobites* 259
Functional morphology. – The function of granules on the pleural tips of the thoracic segments has been discussed by Clarkson & Henry (1973, p. 125) in Encrinurus tuberculatus (Buckland, 1836). They suggested that the small tubercles may have been the sites of contact-sensory organs, both responding to the sea floor when the trilobite was extended, and to contact with the preceding segment when it was enrolled. Furthermore the rougher surface may have aided in the locking of the segments. Subsequently, small tubercles on the pleural tips of Rollmops wenjukowi Schmidt, 1881) were reported by McNamara (1980, pp. 74–76, fig. 10 and 1980a, p. 71, pl. 2, figs. 5–7). In addition this trilobite has granulation on the articulating half rings of the thoracic segments, supporting McNamara’s assumption that it generally lived in an enrolled condition. The preservation of the present thorax of R. granensis does not allow any close study of the articulating half rings, but as far as can be judged they almost certainly are smooth. The chasomipes, to which Rollmops belongs, had unrolled spiral enrollment (see Bergström 1973, p. 5) and could possibly roll up easily. For the remopleuridids, most probably having spiral enrollment, the enrollment may have been more difficult and quite power-requiring. Complete enrolled specimens of Remopleurides hitherto found are apen and not tightly enrolled (cf. this paper pl. 1, figs. 13–15, pl. 5, figs. 1–5, Neben & Krueger 1971, pl. 42, figs. 15–17, Weber 1948, pl. 2, figs. 27–29), and none of these possesses granulated pleural tips. It is possible that R. granensis was the only Remopleurides species hitherto known being able to carry into effect the spiral enrollment, being aided by the granulated anterior pleural bands with their prominent lateral flanges. As opposed to Rollmops wenjukowi, Remopleurides granensis almost certainly did not generally live in an enrolled condition, as indicated by the presence of long librigenal spines and a very long macrospine on the eight thoracic segment. Additionally, if the assumptions above are correct, the unusually strongly granulated pygidium considerably strengthened this trilobite’s ability of staying enrolled for longer periods. Granulation is also found in the posterior part of the pygidium of Rollmops wenjukowi, the part encountered to the cephalon when the trilobite was enrolled. In connection with the suggestions above, it should be mentioned that the possibly related species Remopleurides variolaris n. sp. (pp. 000–000, pl. 7, figs. 1–12, pl. 8, figs. 1–9) has quite smooth, flattened anterior pleural bands together with low fulcral processes, as opposed to the convex anterior pleural bands and strong fulcral processes in R. granensis.

Remarks. – The type material of R. granensis is based on rather poorly preserved material. Størmer (1945, p. 408, pl. 4, fig. 4) only figured the holotype, which is a fragmentary and largely exfoliated cranidium; it does not allow any closer comparison with other species. Subsequent collecting by various workers has produced detached parts of almost the whole trilobite. Mostly the material is very fragmentary, but small parts have given valuable information about the species. R. granensis is one of the most distinguishable Remopleurides species in Norway. The species was originally described as a subspecies of R. latus Olin (1906, pp. 55–56, pl. 2, figs. 5–9), which is from horizons in Scania, Sweden, corresponding to the Solvang Formation of the Oslo Region, but obviously does not have any close relationship with the nominate subspecies. It differs from R. latus in lacking the strong sculptural lines on the median area, and in having a more convex median area and narrower glabellar tongue.

The pygidium figured by Owen (1981, pl. 1, fig. 15) as PMO 106178 is in fact PMO 68642, which is an internal mould. PMO 106178 is a fairly well preserved counterpart, showing the external surface of a pygidium with the very characteristic features described above. The narrow-tongued cranidium of Owen (1981, pl. 1, figs. 8, 10) is by the present author regarded as doubtfully belonging to R. granensis. Its very narrow glabellar tongue recalls that of R. sp. G (p. 264, pl. 6, figs. 9–11) from slightly younger beds of Hadeland and Ringerike. However, if it really belongs to R. granensis, it allows extremely wide limits of variation in this species.

The most similar species is R. nikolaiseni Owen (1981, pp. 15–16, pl. 2, figs. 15–22, pl. 3, figs. 1–7) from beds of late Rawtheyan or early Hirnantian age from various localities in the Oslo Region. The very characteristic granulation on the anterior pleural band of the pleurae of R. granensis is also faintly present in R. nikolaiseni. Other distinctive characters in common are the bulbous fulcral processes and the convex (sag.) pleurae. The pygidium is also similar to that of R. nikolaiseni, but is wider, possesses a shorter rachis, and is coarsely granulated. On the other hand, R. granensis seems to be related to the
slightly older or contemporaneous *R. variolaris* n. sp., as indicated by the shallow longitudinal furrow dividing the first rachial ring in internal moulds of the pygidium in both species; a character not known in any other species. It differs in having a more convex median area and a somewhat shorter glabellar tongue, which is also more parallel-sided in *R. granensis*. Other characters separating the two species are the bulbous fulcal processes and the convex pleurae in the thoracic segments of *R. granensis* as opposed to the low fulcal processes and flattened pleurae in *R. variolaris*. The coarse granulation on the pygidium of *R. granensis* is distinctive, although the overall proportions are almost equal to those of *R. variolaris* (see also p. 256).

*R. granensis* differs from the contemporaneous *R. privus* n. sp. (pp. 251–252, pl. 8, figs. 14–16) of the Solvang Formation of Ringerike by having a more convex median area, a less convex glabellar tongue, and in having the palpebral rims less arched down in lateral view.

Among the British species the closest relatives may be found among the species grouped around *R. colbii*. *R. granensis* differs from *R. colbii* in having a less convex glabellar tongue, in lacking macropleurae on the seventh thoracic segment, and in being coarsely granulated on the anterior pleural bands and on the pygidium. The two latter characters also separate the species from *R. nicholsoni* Reed (1914, pp. 12–14, pl 2, figs. 3–9) from the late Ashgill Starfish Bed, Drummuck Group in Girvan, Scotland. *R. dorsospinitifer* Portlock (1843, p. 256, pl. 1, figs. 3a–d) from the Killey Bridge Formation of Northern Ireland lacks macropleurae on the seventh thoracic segment, but is separated by a narrower glabellar tongue, and as far as can be judged from the illustrations of the holotype (Whittington 1950, pl. 69, figs. 7–8), by lacking the dense granulation on the rachial rings of the thoracic segments.

As pointed out by Owen (1981, p. 13), the cranidium of *R. biaculeatus* Tripp (1954, pp. 664–666, pl. 2, figs. 1–12) from the Caradoc Craighead Mudstones near Girvan, Scotland, has similar proportions to those of *R. granensis*. He noted that both have the same granulation on the thoracic segments, but that *R. granensis* lacks the weak granulation on the median area seen in *R. biaculeatus*. This is only a matter of preservation, and granulation on the median area is also found in some specimens of *R. granensis*, and *R. granensis* may be far more granulated than *R. biaculeatus*.

**Occurrence.** – Solvang Formation: Nerby in Lunner, and Tönnerudodden. Gagnum Shale Member of the Lunner Formation: West of Espen, Granset, west of Høltjernet, east of Mjørenga, north-east shore and south-west shore of Rokotjern, and Vien in Gran. All localities are in the Hadeland district.

**Remopleurides sp. A**

Pl. 3, fig. 11

**Material.** – One almost complete hypostome, PMO 4271. Coll. O. Holtedahl, 1915.

**Description.** – This hypostome has its greatest width across anterior wings. Its width across transverse mid-line being four-thirds the length of the hypostome. Middle body laterally and posteriorly limited by strongly impressed and well defined furrows, anteriorly by a broad and shallow furrow. Anterior margin straight at middle part, laterally slightly oblique backwards downwards. Anterior wing a pointed projection. Shoulder strong and well pronounced. Posterior wing very wide (tr.), obliquely arched downwards and slightly outwards. Postero-lateral projection very strong but blunt. Posterior border broadest at axial line. Middle body very gently convex, composed of two oval areas separated by a shallow longitudinal furrow. The width of oval area is three-quarters the width of hypostome at transverse mid-line, the length being two-thirds that of the hypostome. Middle body with densely spaced and very fine U-shaped sculptural lines on the mesial part, laterally longitudinal and close to the margins directed obliquely outwards.

**Dimensions.** –

| PMO 4271 | 3.9 | 5.3 | 3.4 | 2.6 | 4.3 |

**Remarks.** – The hypostome of *R. ateuchetos* Tripp (1979, pl. 37, fig. 8) from the Lower Llandeilo Stinchar Limestone of Girvan, Scotland, shows similarity to the present specimen. Very short hypostomes are not known in the Norwegian remopleurid material, but are common in Great Britain. *R. sp. A* is the species closest to such forms, although it is distinctly longer. The appearance of this specimen in the Ampyx Limestone corresponds well with the age of the British short hypostomes.

The hypostome is also similar to that of *R.*
affluens n. sp. (pp. 238–241, pl. 1, figs. 6–15, pl. 2, figs. 1–5) from the later upper part of the Lower Chasmops Shale. It differs in being shorter and in having considerably larger posterolateral projections.

Occurrence. – Ampyx Limestone and Shale, 4aβ. Ringerike: Gullerud, western side of Røysetangen.

Remopleurides sp. B
Pl. 3, fig. 12


Description. – The pygidium is three-quarters as long as wide. Rachis half as long as pygidium. Pleural field distinctly convex. Tip of first pleural spine reaching beyond axial end, second pleural spine rather long.

Dimensions. –

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Remarks. – This pygidium recalls that of R. affluens n. sp. (pp. 238–241, pl. 1, figs. 6–15, pl. 2, figs. 1–5) from the upper part of the Lower Chasmops Shale, but differs in being narrower. The stratigraphical occurrence of this specimen indicates that it may possibly belong to R. paucus n. sp. (pp. 236–238, pl. 1, fig. 1–5).

Occurrence. – Ampyx Limestone and Shale, 4aβ. Ringerike: Gullerud, western side of Røysetangen.

Remopleurides sp. C
Pl. 4, figs. 13–15

□ 1973 Remopleurides sp. – Lauritzen, p. 34 (Recorded).

Material. – Three fragmentary cranidia, PMO nos. 64020, 64024 and 82106.

Description. – Cranidium gently convex, as long as wide. Median area 70% as long as wide, smooth. Lateral glabellar furrows not discernible in the present material. Glabellar tongue gently convex (tr.), directed downwards forwards, parallel-sided, 40% as wide as median area, 40% as long as wide, and with a few sculptural lines parallel to the margins. Dorsal furrow narrow and deeply incised. Palpebral furrow narrow, sharply defined and with posterolateral bend very shallow. Anterior rim very narrow, convex (tr.). Palpebral rim rather narrow antero-laterally, moderately convex in cross-section, and very gently arched down in lateral view. Occipital furrow strongly impressed, 50% as wide as median area.

Dimensions. –

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Remarks. – This material almost certainly represents a new species. It is separated from the other Scandinavian and British species by its relatively narrow and rather short glabellar tongue. The closest relative seems to be R. kullsbergensis Warburg (1925, pp. 83–87, pl. 1, figs. 1–6), a species occurring in approximately contemporary beds in Ringerike.


Remopleurides sp. D

Material. – One badly preserved and very fragmentary thorax consisting of seven segments, PMO 37131. Coll. H. Rosendahl, 1931.

Remarks. – The rachial rings are rather wide (tr.), and no macropleurae seems to be present. The specimen does not allow any closer comparison with other material due to the poor preservation, and is recorded here for the sake of completeness. However, the specimen is similar to the thorax of R. affluens n. sp. (pp. 238–241, pl. 1, figs. 6–15, pl. 2, figs. 1–5).
Occurrence. – Coelosphaeridium Beds, Furuberg Formation. Ringsaker: Creek below Holmen and Vollenga, Brumunddal.

Remopleurides sp. E
Pl. 9, fig. 8

\[1909\] Remopleurides dorsospinifer, Portl. – Holtedahl, pp. 19, 31 and 40 (Listed).

Material. – One almost complete but mostly exfoliated cranidium, PMO 74741. Coll. O. Holtedahl, 1907.

Description. – Cranidium almost nine-tens as long as wide. Median area quite convex, almost two-thirds as long as wide, and completely smooth. Three pairs of faint lateral glabellar furrows, easily seen as differences in colour on the test.

Dimensions. –

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Remarks. – This specimen seems to be related to other contemporaneous species of the Oslo Region. It mostly resembles R. lunnerensis n. sp. (pp. 246–248, pl. 4, figs. 1–12) from the upper part of the Kirkerud Group in Hadeland. However, R. lunnerensis has a narrower glabellar tongue, distinct granulation both on median area and occipital ring, and a shorter occipital furrow. The same characters as above also separate the equally similar R. perspicax n. sp. (pp. 248–251, pl. 5, figs. 1–6, pl. 6, figs. 1–8) from slightly younger strata of Oslo–Asker and Ringerike.

R. sp. E differs from R. variolaris n. sp. (pp. 253–257, pl. 7, figs. 1–12, pl. 8, figs. 1–9) from the somewhat younger Solvang Formation of the Oslo–Asker district in having a less forwardly pointed and less convex glabellar tongue, which also is narrower and shorter, and in having a clearly wider (tr.) occipital furrow. Additionally the transversely convex posterior fixigenae of R. sp. E denies a close relationship to R. variolaris. The last character also separates it from R. praevarius n. sp. (pp. 251–252, pl. 8, figs. 14–16) from the top of the Solvang Formation in Ringerike. Otherwise, this species is quite similar in shape and proportions, but differs in having rather narrow palpebral rims and less convex (tr.) glabellar tongue.

\[Sl\] broad (exsag.) and relatively strongly curved. S2 narrow and very gently convex forwards. S3 broader than S2. Glabellar tongue moderately convex (tr.), parallel-sided, two-fifths as wide as median area, half as long as wide, smooth and with anterior margin straight. Dorsal furrow narrow (tr.) but distinctly engraved. Palpebral furrow strongly impressed, with postero-lateral bend rather distinct. Anterior pit shallow. Anterior rim very narrow (tr.). Palpebral rim of moderate width and very slightly convex in cross-section, distinctly arched down in lateral view. Occipital furrow deep, strongly impressed, straight, and slightly more than half as wide as median area. Occipital ring flattened longitudinally, smooth except for serrated posterior margin. Occipital tubercle very small. Posterior fixigena parallel-sided (tr.), strongly convex transversely, slightly convex longitudinally, and with anterior margin strongly arched down.


Remopleurides sp. F
Pl. 4, fig. 16


Description. – The fourth thoracic segment counted from behind possesses a very strong macrospine. Rachial rings of thoracic segments with transverse sculptural lines, faintly and scarcely granulated, and with posterior margin strongly serrated. Fulcral processes very large and bulbous. Pygidium with rachis three-quarters as long as pygidium at axial line, strongly convex both transversely and longitudinally. Ring furrow strongly impressed. Second rachial ring divided into two oval convex areas by wide shallow longitudinal furrow. Muscle scar strongly impressed. Pleural field distinctly convex. Tip of first pleural spine reaching beyond axial end of pygidium. Second pleural spine relatively long. Scarcely and faint granulation all over the pygidium, and with transverse sculptural lines on rachis.
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Remarks. — This specimen seems to occupy an intermediate position between *R. affluens* n. sp. (pp. 238–241, pl. 1, figs. 6–15, pl. 2, figs. 1–5) from lower Caradoc beds and *R. lunnerensis* n. sp. (pp. 246–248, pl. 4, figs. 1–12) together with *R. perspicax* n. sp. (pp. 248–251, pl. 5, figs. 1–6, pl. 6, figs. 1–8) from upper Caradoc beds. The proportions point towards *R. affluens*, whereas the ornamentation is rather similar to that of the two other species. The stratigraphical position of *R. sp. F* also is intermediate, at least with respect to *R. affluens* and *R. perspicax*.

Occurrence. — Upper Chasmops Shale, 4by. Oslo–Asker: Northern railroad tunnel at Hvalstad in Asker.

Remopleurides sp. G

Pl. 6, figs. 9–11

Material. — Three fragmentary cranidia, PMO nos. 64590, 74726 and 74989.

Dimensions. —

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Remarks. — *R. sp. G* resembles the cranidia figured by Owen (1981, pl. 1, figs. 19–23) as *R. cf. granensis* from the lower Ashgill Grimsoya Formation and lower Sørbakken Formation of Oslo–Asker and Ringerike, which also have a rather narrow glabellar tongue. However, the cranidium differs in having the glabellar tongue much more flattened (tr.) than in *R. sp. G*, together with a convex anterior margin. The strong granulation on the glabellar tongue in *R. cf. granensis* is perhaps the most distinguishing character.


Remopleurides sp. H

Pl. 9, figs. 5–7

！1979 Remopleurides sp. nov. — Owen, p. 251 (Listed). ！1979 Remopleurides sp. nov. B. — Bruton & Owen, p. 218 (Listed).

Description. — Cranidium about as long as wide. Median area three-quarters as long as wide, moderately convex, smooth except for very small nodes along lateral and postero-lateral margins. The three pairs of lateral glabellar furrows are barely discernible in one of the specimens. Glabellar tongue one-third as wide as median area, about as long as wide, rather convex, with anterior margin concave, and with strong, transverse sculptural lines. Dorsal and palpebral furrows strongly impressed, postero-lateral bend conspicuous. Anterior rim very narrow. Palpebral rim broad (tr.), of about even width anterolaterally and laterally, posteriorly considerably wider due to postero-lateral bend of palpebral furrow, roughly triangular in cross-section, and slightly arched down in lateral view. Occipital furrow almost straight, relatively shallow, and less than half as wide as median area. Occipital ring gently convex longitudinally, very strongly convex transversely, and with very strong, wavy, transverse sculptural lines. Occipital tubercle large and prominent.


Description. — The present cranidium, which is relatively small, has a gently convex median area with very coarse and distinctive granulation. The three pairs of lateral glabellar furrows are shallow but distinctly impressed. S1 is broad (exsag.), strongly convex forwards and one-quarter as long as width of median area. S2 slightly curved, rather narrow (exsag.) and slightly longer than S1. S3 very short, almost pit-like. Palpebral furrow deeply impressed, with a conspicuous postero-lateral bend. Palpebral rim broad laterally, slightly convex in cross-section. Occipital furrow straight, sharply defined and two-fifths as wide as median area. Occipital ring broad (sag.), slightly convex longitudinally, very strongly convex transversely, and with coarse and conspicuous granulation. Posterior fixigena parallel-sided (tr.), flattened longitudinally, moderately convex...
transversely, and with anterior margin moderately arched down. Occipital tubercle prominent.

Librigena provided with a strong genal spine, with lateral margin even with lateral margin of spine. Posterior border furrow very strongly impressed, directed outwards and slightly forwards, and not reaching genal notch. Postero-lateral corner blunt, due to the large and wide genal notch. Antero-lateral margin with a broad smooth field. Sculptural lines very strong, wrinkle-like, subparallel to eye socle.

**Dimensions.**

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**Remarks.** R. sp. H undoubtedly represents a new species, but more complete material is needed to justify its erection. With its even lateral margin of the librigena, and also the oblique posterior border furrow, the species strongly approach *R. variolaris* n. sp. (pp. 253–257, pl. 7, figs. 1–12, pl. 8, figs. 1–9) from slightly older beds. The low fulcral processes and flattened pleurae supports this view. However, the cranium is easily separated by its short (tr.) occipital furrow and its broad (sag.) occipital ring, besides the strong granulation on the median area.

A noteworthy feature is the distinctly impressed lateral glabellar furrows. In other species of the Oslo Region the lateral glabellar furrows are usually only seen as differences in the colour, or as extremely faintly raised stripes.

**Occurence.** Høgberg Member of the Solvang Formation. Ringerike: Western side of Frognerøya, Lake Tyrifjorden.

### Remopleurides deani n. nom.

□ 1958 *Remopleurides* sp. nov. – Dean, p. 224 (Recorded). □ 1963 *Remopleurides warburgae* sp. nov. – Dean, p. 246, pl. 46, figs. 1–2 (Descr. and figs. of holotype cranidium).

**Name.** The name is given in honour of Professor W. T. Dean.

**Type data.** Holotype is the cranidium (BM In. 49751) figured by Dean 1963, pl. 46, figs. 1–2 as *R. warburgae* from the uppermost Actonian Stage in the north bank of the River Onny in Shropshire, Great Britain.

### Genus Sculptella n. gen.

**Name.** Diminutive of Latin *sculptus*, carve, hew, cut, chisel, referring to the densely sculptured dorsal shield.

**Type species.** *Sculptella scripta* n. gen., n. sp., from the Ampyx Limestone, 4aβ, at western side of Bygdøy, opposite Kaffeskjær, Oslo, Oslo–Asker district.

**Diagnosis.** A remopleuridid genus with: the outline of cranidium like that of *Remopleurides*; median area with densely spaced sculptural lines; three pairs of lateral glabellar furrows discernible only as smooth stripes interrupting the sculpture; glabellar tongue very gently convex, less than one-quarter as wide as median area; preglabellar field distinct and extending across anterior part of glabella, preglabellar furrow weakly defined or absent; librigena with very long and strong genal spine; very narrow anteriorly and antero-laterally, lateral margin almost even with lateral margin of spine, junction of median and hypostomal suture not strongly pointed; hypostome gently convex, median area with shallow V-shaped furrow separating the oval areas; thoracic segments transversely gently convex, fulcral processes low, pleurae gently convex; pygidium with distinct postrachial ridge, first pair of pleural thoracic segment with low fulcral processes. Pleura very gently convex. Anterior pleural band, except for a smooth field along anterior margin, with very strong, slightly wavy sculptural lines directed from fulcrum process to lateral margin. Pleural furrow very sharply defined. Posterior pleural band wedge-shaped, with very strong sculptural lines parallel to those on anterior pleural band. Rachial ring with strong, forcibly convex sculptural lines.

**Remarks.** The name *Remopleurides warburgae* was previously given to a specimen from a drift boulder in northern Germany by Kummerow in 1928 (pp. 6–7, pl. 1, figs. 4a–b). According to the ICZN, Article 59 (a), the name given to the British species therefore has to be changed.
spines clearly extending beyond tips of smaller second pair; test of the whole dorsal shield rather thin.

*Included species.* – *S. scripta* n. gen., n. sp., *S. angustilingua* n. gen., n. sp., *S. scriptoides* n. gen., n. sp., and possibly also *S. (?) nonscripta* n. gen., n. sp., *Remopleurides salteri* Reed, 1899 and *R. amphitryonoides* Lu, 1975.

*Remarks.* – This new genus bears strong resemblance to Arenig remopleuridid specimens of Scandinavia referred to *Remopleuridiella*. The latter genus was established by Ross 1951, based on the species *Remopleuridiella caudalimbata* from the Tremadoc Garden City Formation of southeastern Idaho, USA. *R. caudalimbata* is a remopleuridid with the base of the genal spine located very far forwards, and a pygidium with five pairs of pleural spines (cf. text-fig. 3a–b).

Since 1954 several Arenig remopleuridid trilobites have been assigned to *Remopleuridiella*, the justification for this was commonly weak. The first to be described were those of Tjernvik (1956, pp. 203–204, pl. 2, figs. 5–6); *R. sp. no. 1* from the early Arenig Zone of *Plesiomegalaspis plantlimbata* and *R. sp. no. 2* from the slightly younger Zone of *Plesiomegalaspis estonica*, both in Sweden. *R. sp. no. 1* is known from both cranidia and librigenae (cf. text-fig. 3c). The base of the genal spine in this species is located slightly further backwards than in *Remopleuridiella caudalimbata*. The pygidium is not known in this species, but has been found in *R. sp. no. 2*. Unfortunately the specimen disintegrated soon after it was collected, but before it completely crumbled, Dr. T. Tjernvik hastily made a sketch of the pygidium. He has kindly sent the present author the drawing (1970), which is reproduced in text-fig. 3d. The pygidium shows some resemblance to that of *Remopleuridiella*, but has only three pairs of pleural spines instead of five, the inner pair being the smallest. The median area of *R. sp. no. 2* has an ornamentation of transverse sculptural lines, and the pattern of this ornamentation is almost identical to that found in the Norwegian material described by Skjeseth (1952, pp. 157–158, pl. 5, figs. 4a, 6, 10) as *Remopleurides aff. nanus*, from the Zone of *Plesiomegalaspis estonica* in Ringsaker. Both the Swedish and Norwegian specimens are apparently conspecific with *Remopleuridiella groenwalli* Poulsen (1965, pp. 63–64, pl. 1, fig. 4) from the Zone of *Cyclopyge stigmata* in Bornholm, Denmark. Neither the Danish nor the Norwegian material from the Arenig includes any librigenae or pygidia. If the pygidium, when found, possessed three pairs of pleural spines, the species, as well as *R. sp. no. 1* of Tjernvik, should probably be assigned to a new genus rather than to *Remopleuridiella*. If provided only with two pairs, it should be included in *Sculptella* or possibly the probably closely related genus *Sculptaspis* n. gen. Another feature of the Scandinavian specimens separating them from *Remopleuridiella* is the much narrower glabellar tongue. The Tremadoc-Lower Arenig species *Remopleuridiella*? *obtusa* Flower (1968, p. 26, pl. 6, figs. 5–11) from New York, USA, and the Arenig *Remopleuridiella angularis* Young (1973, pp. 112–114, pl. 1, figs. 21–22, 25–27) from western Utah, USA, certainly differ from the Scandinavian forms in their wide-based, rapidly forward-tapering glabellar tongue and the very wide occipital furrow. The resulting shape of the cranidium suggests that they are not closely related to the Scandinavian forms. Possibly *R. (?) obtusa* and *R. angularis* represent another branch in the evolution of remopleurids.

It seems most likely that *Sculptella* has developed from species such as the Arenig ones cited above, or from very closely related forms, developed from the Tremadoc genus *Remopleuridiella*. Parallel to the reduction in number of pygidial pleural spines, the base of the genal spine is drawn gradually further rearwards. In *S. angustilingua* n. gen., n. sp. one specimen of the librigenae has a very large genal notch (cf. text-fig. 3e, pl. 10, fig. 17), thus being intermediate between other librigenae of the same species (as well as those of other species of *Sculptella*) and that of *Remopleuridiella* sp. no. 1 of Tjernvik. It may thus be an atavistic feature. This evolutionary line does not end with *Sculptella*, but is continued further along the same trend into the late Caradoc-Ashgill genus *Remopleurella* Dean 1963. The pygidium of this genus still has two pairs of pleural spines as in *Sculptella*, but they have become smaller and are drawn much further backwards, i.e. the distance between rachial end and axial end is increased (cf. text-figs. 3d, g and i). The genal notch found in the librigenae of *Sculptella* has disappeared in *Remopleurella* as the base of the genal spine has been drawn fully backwards, following the trend in the earlier relatives. The serrated posterior margin of the occipital ring and the rachial rings of the thorax as found in *Sculptella*, though not very strongly pronounced, have also become completely smooth.
This evolutionary trend terminates with the Ashgill genus *Amphitryon* Hawle & Corda, 1847, which is very close to *Remopleurella*. In *Amphitryon* the distance between rachial end and axial end of pygidium is slightly longer than in *Remopleurella* and the librigenae are normally considerably wider. A slight widening of the librigenae has also taken place from *Sculptella* to *Remopleurella*. However, the great difference in the glabellar tongue in *Remopleurella* and *Amphitryon* suggests different species of *Sculptella* as the respective precursors (cf. p. 289).

The cranidium from the upper Llanvirn *Didymograptus murchisoni* Beds of Pupiao, western Yunnan, south-western China, described as *Remopleurides aff. latus* by Reed (1917, p. 41, pl. 6, fig. 9) is remarkably similar to the cranidium of the Arenig *Remopleureudiella groenwalli* Poulsen (1965, pp. 63–64, pl. 1, fig. 4) from Bornholm, Denmark. It has, however, a distinctly narrower glabellar tongue than the Danish species, and in this respect is more like the Norwegian Llandeilo species *Sculptella scriptoides* n. gen., n. sp. (pp. 271–272, pl. 10, figs. 1–8). The librigena associated with the Chinese cranidium (Reed 1917, p. 41, pl. 6, fig. 10) has the genal spine based at transverse mid-line, and seems to occupy an intermediate position between that of Tjernvik’s *Remopleureudiella* sp. no. 1 (1956, pp. 203–204, pl. 2, fig. 6) and the possibly atavistic one of *Sculptella angustilingua* (pl. 10, fig. 17). Obviously the Chinese species fits remarkably well into the evolutionary lineage from *Remopleureudiella* through *Sculptella* to *Amphitryon* suggested here. However, without the pygidium it is uncertain whether the Chinese species belongs to *Sculptella* or to an earlier genus.

*Sculptella* also seems to be related to *Sculptaspis* n. gen. (for discussion see p. 276). The cranidium of the latter is distinguished from *Sculptella* by possessing a very thick test, very strongly incised dorsal, palpebral, and occipital furrows and a well defined preglabellar furrow. The librigenae of *Scultpaspis* are separated from those of *Sculptella* by having much smaller genal spines, and the lateral margin of which form a distinct angle with that of the librigenae proper. The narrow smooth field along the lateral margin of the librigena proper continues on the lateral margin of the genal spine in *Sculptella* (and in *Remopleurella*), whereas this smooth field ends at the base of the genal spine in *Scultpaspis*.

At present, the genus is known only with certainty from the Ampyx Limestone of the Oslo-
obviously very closely related to *S. (?) nonscripta* n. gen., n. sp., a species questionably included in this genus. If *S. (?) nonscripta* is a true *Sculptella*, it follows that so is *R. amphitryonoides*. The age of the Chinese species seems to correspond well with that of the Norwegian.

Remopleurid cranidia and thoraces from Upper Naungkangyi Beds (?Lower Ordovician) of the Northern Shan States, Burma, were described and figured by Reed (1906, pp. 69–70, pl. 4, fig. 17, and 1915, p. 28, pl. 5, figs. 9–10) as *Remopleurides* sp. The relationship of these specimens with others is difficult to decide on the basis of Reed’s short descriptions and illustrations. The Burmese species can be compared with *Sculptella* (?) *salteri* (Reed, 1899, pp. 747–748, pl. 49 figs. 1–3) from the upper Llandeilo-lower Caradoc beds of Ireland, or *S. (?) amphitryonoides* (Lu, 1975, pp. 302–303, pl. 4, figs. 16–18) and *S. (?) nonscripta* n. gen., n. sp. (pp. 274–276, pl. 13, figs. 4–13) from approximately coeval rocks of south-western China and Norway respectively. Indications of such relationship of the Burmese species to the others is the general shape of the cranidium with the narrow glabellar tongue and short occipital furrow. The librigenae from the Naungkangyi Series of Southern Shan States, Burma, described and figured by Reed (1936, pp. 55–56, pl. 6, fig. 6) as *Remopleurides* sp. is not from a remopleurid trilobite, but belongs most probably to *Telephina*.

The lower Llanvirn species *Remopleurides warburgae* Kummerow (1928, pp. 6–7, pl. 1, figs. 4a–b) from a drift block in northern Germany has a few characters recalling *Sculptella*, i. e. the wide median area and the very short (tr.) occipital furrow. It differs, however, in having a fairly wide glabellar tongue and palpebral rims strongly arched down in lateral view. Although *R. warburgae* has a wide glabellar tongue and possibly lacks a preglabellar fields, the very short occipital furrow clearly denies its assignment to *Remopleurides*. Possibly *R. warburgae* represents a separate genus branching from the *Remopleuridiella-Amphitryon* lineage.

*Sculptella scripta* n. gen., n. sp.
Pl. 9, figs. 9–18, text-figs. 4–5

□ 1887 Remopleurides sp. – Brøgger, p. 17 (Recorded).

**Name.** – From Latin *scriptura*, a writing, referring to the dense sculpture on the median area.


**Type stratum and type locality.** – Lower part of the Ampyx Limestone, 4aβ. Western side of Bygdøy, opposite Kaffeskjær, Oslo, Oslo-Asker district.

**Other material.** – More than twenty cranidia, two hypostomes most probably belonging to this species, a few fragmentary detached thoracic segments, three less well preserved doublures of librigenae, three fragmentary pygidia, and one transitory meraspid pygidium.

**Diagnosis.** – Median area three-quarters as long as wide, with sculptural lines gently convex forwards or transverse. Glabellar tongue almost one-fifth as wide as median area. Occipital furrow more than two-fifths as wide as median area. Pygidium with both pairs of pleural spines small.

**Description.** – Cranidium 90% as long as wide, gently convex. Median area very gently convex, 70% as long as wide, greatest width somewhat behind transverse mid-line, sculptural lines rather strongly disarranged, gently convex or at posterior part transverse. The three pairs of lateral glabellar furrows are very faintly discernible as smooth stripes on the test. S1 convex forwards, 28% as long as width of median area. S2 of about equal length as S1, nearly straight. S3 short, only 26% as long as S1. Glabellar tongue very gently convex, 18% as wide as median area, 63% as wide as long, tapering forwards, and with thin but densely spaced, distinctly convex sculptural lines. Preglabellar furrow not defined. Preglabellar field concave (sag.), not sharply defined, but is limited anteriorly by the slightly concave anterior margin, posteriorly by the convex (tr.) transition from concave area to glabellar tongue, thus being narrower at axial line than at lateral parts, its length at axial line about one-eight that of glabellar tongue, and with transverse sculptural lines. Anterior pit small and very low but well defined. Dorsal furrow very shallow, narrow and sharply defined. Palpebral furrow moderately deep anteriorly, becoming gradually shallower rearwards, and with a distinct postero-lateral bend. Anterior rim extremely low, flattened and tapering in width forwards. Palpebral rim gently convex anteriorly, flattening rapidly rearwards, about two-fifths as wide at
Fig. 4. Sculptella scripta n. gen., n. sp.
Holotype cranidium, pl. 9, figs. 9–11, 14.
Ampyx Limestone, 4aß. Western side of
Bygdøy, opposite Kaffeskjær, Oslo. PMO
74666. × 9.

Fig. 5. Sculptella scripta n. gen., sp. Para-
type pygidium, pl. 9, fig. 17. Ampyx
Limestone, 4aß.Huk, Bygdøy in Olso.
PMO 3724. × 16.

transverse mid-line as at postero-lateral part, and
with thin and closely spaced sculptural lines run-
ning forwards outwards. Occipital furrow nar-
row, rather shallow, straight or slightly convex
forwards, and 42 % as wide as median area. Oc-
cipital ring rather convex transversely, very gen-
tly convex longitudinally, and with dense, for-
wardly strongly convex sculptural lines. Occipital
tubercle small, located close to occipital furrow.
Posterior fixigena wedge-shaped, flattened trans-
versely, but very gently convex longitudinally.

Only the doublure is known with certainty of
the librigena. Corner between median and hy-
postomal suture rather low, not pointed. Pit lo-
cated close to median suture and distinctly closer
to anterior margin than hypostomal suture.
Groove from pit to hypostomal suture not pre-
sent.

Hypostome gently convex, 79 % as long as
wide, maximum width across transverse mid-
line. Anterior margin rather convex. Anterior
border furrow shallow and broad (sag.). Lateral
border furrow very narrow and almost semi-cir-
cular. Posterior border furrow very broad (sag.)
but well defined. Median boss small but promi-

tent. Anterior wing a short rounded projection
strongly bent down. Oval areas separated from
each other by a large triangular-shaped field
where the test is very thin. Shoulder rather nar-
row, evenly rounded. Postero-lateral projection
very short. Posterior margin slightly curved.

Thoracic segments with rachial ring almost half
as wide (tr.) as the complete segment, almost
one-third as long as wide, moderately convex
transversely, very gently convex longitudinally,
and with very fine and very closely spaced,
strongly convex sculptural lines. Ring furrow
shallow but broad (sag.). Articulating half ring
gently convex (sag.), about one-third as long as
rachial ring. Pleura more than half as wide as
rachial ring, rather flat close to dorsal furrow,
with a conspicuous ridge-like pleural furrow run-
ning from the fulcral process to the lateral mar-
gin of the spine-like tip of posterior pleural band,
giving the pleura a low tringular shape in cross-
section. Sculptural lines on anterior pleural band
subparallel to lateral margin, on posterior pleural
band very fine and closely spaced, spreading fan-
like outwards from posterior inner corner. Dor-
sal furrow very shallow.

Pygidium 96 % as wide as long. Rachis 64 % as
long as wide, 58 % as wide as pygidium and 36 %

long, moderately convex both transversely and
longitudinally. Articulating half ring very large,
with the mesial part somewhat narrower than
lateral parts. Articulating ring furrow relatively
shallow, concave, with a straight mesial part.
First rachial ring well defined, narrow at mesial
part, rapidly widening laterally where it is about
twice as broad as at axial line, and with a few
slightly concave sculptural lines together with a
few large nodes concentrated at mesial part. Sec-
ond rachial ring divided by a longitudinal shallow
but broad furrow into two rounded triangular
and very slightly convex areas, with transverse
sculptural lines and low but relatively large
nodes. Muscle scar very shallow. Postrachial
ridge large but not sharply defined, with small
and densely distributed nodes. Dorsal furrow
shallow but distinct laterally and postero-lateral-
ly. Fulcral process very low. Pleural furrow very
prominent, running straight backwards to the
level of second rachial ring, then obliquely outwards to reach lateral margin of pygidium at the level about half-way between rachial end and axial end. Sculptural lines outside pleural furrow subparallel to lateral margin. Interpleural furrow not present. Pleural area inside pleural furrows with transverse sculptural lines and a few small scattered nodes. First pair of pleural spines gently convex (tr.) about twice as long as second pair and reaching somewhat beyond tips of these. Second pair small, flattened and triangular.

**Meraspid stage.** – One meraspid pygidium belonging to this species is present. The pygidium corresponds very well with the transitory pygidia of degree 0 of Whittington (1959, pp. 398–399) and paraprotaspid stage of Hu (1975, p. 37). This subject was thoroughly treated by Whittington and subsequently by Hu, based on excellently preserved silicified material from Virginia, U.S.A. Nothing further can be added to the general knowledge of remopleuridid ontogeny on basis of the present pygidium. It may be noticed that the rachis has five rachial rings, but only three pairs of marginal spines are discernible.

**Dimensions.**

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**Remarks.** – *S. scripta* is obviously very closely related to *S. scriptoides* n. gen., n. sp. (pp. 271–272, pl. 10, figs. 1–8). *S. scripta* occurs in the lower and middle part of the Ampyx Limestone of the Oslo–Asker district and may have given rise to *S. scriptoides*, which appears in the upper part of the Ampyx Limestone. It differs from *S. scriptoides* in having a more flattened glabellar tongue, shallower dorsal furrows, sculptural lines convex or transverse on median area, and in having a much shorter first pair of pleural spines in the pygidium.

*S. angustilingua* n. gen., n. sp. (pp. 272–274, pl. 10, figs. 9–17, pl. 11, figs. 1–4) from the lowermost part of the Ampyx Limestone and Shale of Ringerike may also be related. This species is separated from *S. scripta* in having a much narrower glabellar tongue, strongly concave forwards sculptural lines on the median area and a narrower and more sharply defined postrachial ridge on the pygidium.

The Irish species *Remopleurides portlocki* Reed (1899, pp. 746–747, pl. 49, fig. 4) from the upper Llandeilo-lowermost Caradoc Tramore Limestone Formation is rather similar in the shape of median area and sculptural lines, but it markedly differs in its much wider glabellar tongue. If the Irish species possesses a preglabellar field (not reported by Reed), it may belong to *Sculptella* in spite of its rather broad glabellar tongue, or possibly more probably to *Sculptaspis* n. gen. (cf. p. 277). Nevertheless, the stratigraphic horizon of *R. portlocki* corresponds perfectly well with that of the genus *Sculptella* in Norway.


**Sculptella aff. scripta** n. gen., n. sp.

Pl. 13, figs. 14–15

Remarks. – This cranidium is very similar to that of *S. scripta*, but has a shorter and relatively wider glabellar tongue. The test is almost completely smooth, but this is most probably due to preservation.

Occurrence. – Ampyx Limestone and Shale, 4aβ. Gullerud, western side of Røysetangen, Ringerike.

Sculptella scriptoides n. gen., n. sp.
Pl. 10, figs. 1–8, text-fig. 6

1940 *Remopleurides* sp. – Grorud, p. 160 (Recorded).

Name. – From Latin *scriptura*, a writing, and the suffix *oides*, like, resembling, having the form of, referring to the likeness to the type species *S. scripta* n. gen., n. sp.


Type stratum and type locality. – Upper part of Ampyx Limestone, 4aβ. Islet at Vollen in Asker, Oslo–Asker district.

Other material. – Eleven cranidia, five librigenae, four thoracic segments, and four pygidia, all material fragmentary but quite well preserved.

Diagnosis. – Median area two-thirds as long as wide, with sculptural lines concave forwards mesially. Glabellar tongue almost one-fifth as wide as median area. Occipital furrow two-fifths as wide as median area. Pygidium with weakly defined postriorchial ridge, first pair of pleural spines very long.

Description. – Cranidium 90 % as long as wide and gently convex. Median area very gently convex, 60 % as long as wide, greatest width somewhat behind transverse mid-line, sculptural lines very thin and closely spaced, somewhat disarranged but mainly distinctly concave forwards and with a few small nodes along postero-lateral margins. Three pairs of lateral glabellar furrows are very faintly discernible as smooth stripes on the test. S1 gently convex forwards, 28 % as long as width of median area. S2 slightly convex forwards, 85 % as long as S1. S3 short, oval, about 25 % as long as S1. Glabellar tongue gently convex, 19 % as wide as median area, 65 % as wide as long, slightly tapering forwards, and with thin and closely spaced, slightly convex forwards sculptural lines. Preglabellar furrow slightly convex, shallow and very weakly defined. Preglabellar field flattened at mesial part, laterally slightly concave (exsag.), of even width (sag.), its length being about 10 % that of glabellar tongue, and apparently smooth. Anterior pit small and very low but well defined. Dorsal furrow relatively deep and broad (tr.). Palpebral furrow rather deep both anteriorly and posteriorly, and with a very distinct postero-lateral bend. Anterior rim flattened and very low, tapering very slightly forwards. Palpebral rim convex anteriorly, flattening rapidly rearwards, about two-fifths as broad at transverse mid-line as at postero-lateral corner, and with thin, slightly wavy sculptural lines directed abaxially forwards outwards. Occipital furrow broad (sag.) and deep, slightly convex, and 40 % as wide as median area. Occipital ring rather convex transversely, very gently convex longitudinally, with very thin and very closely spaced, convex forwards sculptural lines, and with postero-lateral margins weakly serrated. Occipital tubercle prominent, located close to...
to occipital furrow. Posterior fixigena narrow (exsag.), parallel-sided, gently convex transversely, flattened longitudinally, and with anterior margin gently arched down.

Librigena very narrow anteriorly and anterolaterally, distinctly convex (tr.) postero-laterally, the angle with the surface of the eye being 170° antero-laterally, and provided with a very long and very strong, gently curved genal spine. The length of the spine is more than that of librigena proper, with the lateral margin almost even with that of librigena proper. Postero-lateral corner distinctly pointed and slightly arched down. Genal notch very small and narrow (tr.). Posterolateral furrow not present. Eye socle narrow, triangular in cross-section laterally and posteriorly, and fading some distance before the anterior facial suture. Eye socle furrow broad and shallow. Sculptural lines subparallel to eye socle on librigena proper, on spine obliquely forwards outwards. A narrow smooth field runs along lateral margin of both librigena proper and genal spine. Doublure not properly known.

Hypostome unknown.

Thoracic segments with rachial ring almost half as wide as complete segment, moderately convex transversely, very gently convex longitudinally, with very fine and very closely spaced, strongly convex forwards sculptural lines, and with postero-lateral margins weakly serrated. Ring furrow broad (sag.) and shallow. Sculptural lines subparallel to eye socle on librigena proper, on spine obliquely forwards outwards. A narrow smooth field runs along lateral margin of both librigena proper and genal spine. Doublure not properly known.

Dimensions. –

\[
\begin{array}{cccccc}
\text{b} & \text{b}_1 & \text{c} & \text{j} & \text{j}_1 & \text{k}_{00} \\
\text{PMO 74674} & 4.7 & 5.9 & 1.1 & 7.2 & 6.6 & 2.6 \\
\text{PMO 74675} & 5.8 & 7.3 & 1.4 & 8.7^* & 7.9^* & 3.4^* \\
\text{PMO 81811} & 3.4^* & 1.8^* & 1.2 & 2.2 & 4.3 & 3.0 \\
\end{array}
\]

Remarks. – As stated above, this species is obviously closely related to the very slightly older S. scripta n. gen., n. sp. (pp. 268–270, pl. 9, figs. 9–18, text-figs. 4–5). For further discussion see under S. scripta (p. 270).

Occurrence. – Upper part of Ampyx Limestone, 4aβ. Oslo–Asker: Huk and Paradisbukta at Bygdøy, Kaffeskjeær and Tørtberg in Oslo, Håkavik and islet at Vollen in Asker, and southwestern side of Íldjernet in Nesodden. The species seems to be very common and may be expected to be found wherever beds of this horizon crops out in the district. Ringerike: Gullerud, western side of Røysetangen.

\[\text{Sculptella angustilingua n. gen., n. sp.}\]

Pl. 10, figs. 9–17, pl. 11, figs. 1–4, text-fig. 7

□ 1953 Remopleurides sp. – Størmer, p. 84 (Recorded).

Name. – From Latin angustus, narrow, tight, slender, thin, and lingua, tongue, referring to the very narrow glabellar tongue.
Holotype. – A small but well preserved and almost complete cranidium, PMO 4246. Coll. J. Kiær, 1915. Pl. 10, figs. 11–13.

Type stratum and type locality. – Lower part of Ampyx Limestone and Shale, 4aβ. Norderhov, Ringerike.

Other material. – Several more or less fragmentary cranidia, three librigenae, one hypostome, two thoracic segments, and one pygidium.

Diagnosis. – Median area two-thirds as long as wide, with sculptural lines V-shaped mesially. Glabellar tongue only one-seventh as wide as median area, less than half as wide as long. Occipital furrow slightly more than one-third as wide as median area. Hypostome with large but low, triangular median boss. Pygidium with narrow, sharply defined postostracal ridge.

Description. – Cranidium 84% as long as wide. Median area very gently convex or almost flattened, 67% as long as wide, greatest width distinctly behind transverse mid-line, sculptural lines rather strong and very closely spaced, V-shaped at anterior mesial part but somewhat more U-shaped further back. The three pairs of rather short lateral glabellar furrows are only discernible as smooth stripes interrupting the sculpture. S1 moderately convex forwards, 25% as long as width of median area. S2 very slightly convex forwards and 28% as long as width of median area. S3 very short, almost invisible and only 15% as long as S2. Glabellar tongue flattened or very gently convex (tr.), only 15% as wide as median area, 47% as wide as long, slightly tapering forwards, and with thin but closely spaced sculptural lines being slightly convex forwards close to median area but gradually becoming more and more convex towards anterior margin. Preglabellar furrow not defined, but indicated by the difference in sculpture on each side (sag.), and may be drawn roughly as a line between the anterior pits. Preglabellar field 12% as long as glabellar tongue at axial line but increasing distinctly in width laterally, slightly convex transversely, flattened longitudinally at axial line but slightly concave laterally, and with sculptural lines strongly concave forwards. Anterior pit small but distinct. Dorsal furrow deep and narrow. Palpebral furrow deep anteriorly, becoming shallower rearwards, and with a relatively deep and rather conspicuous postero-lateral bend. Anterior rim broad (tr.), flattened or slightly convex, and tapering forwards. Palpebral rim gently convex anteriorly, flattening rearwards, about three times as broad postero-laterally as at transverse mid-line, and with thin and closely spaced sculptural lines parallel to margins. Occipital furrow narrow, very shallow and straight, 36% as wide as median area. Occipital ring very strongly convex transversely, almost flat longitudinally, with strong, distinctly convex forwards sculptural lines, and with posterior fixigena narrow (exsag.), parallel-sided, flattened transversely and gently convex longitudinally.

Librigena very narrow anteriorly and antero-laterally, distinctly convex (tr.) postero-laterally, the angle with the surface of the eye varying from 120° to almost 180° at antero-lateral part, and with a strong and gently curved genal spine, length of which is less than that of librigena proper. Postero-lateral corner blunt and distinctly arched down. Genal notch very small in two of the specimens (pl. 10, figs. 15–16), in the third specimen extremely large and deeply incised (pl. 10, fig. 17). Posterior border furrow not present. Eye socle roughly triangular in cross-section, prominent posteriorly, but tapering forwards and vanishing about one-quarter the length of librigena proper from facial suture. Sculptural lines running subparallel to eye socle on librigena proper, on spine obliquely abaxially forwards. A narrow smooth field runs along lateral margin of both librigena proper and spine. Doublure not known.

Hypostome very gently convex, about as wide as long, anterior margin convex. Anterior border furrow narrow (sag.) and very shallow. Posterior border furrow very broad (sag.) and very shal-
low. Anterior boss a large, extremely thin-tested, triangular, weakly elevated field separating the two oval areas, its length being half that of hypostome. Oval areas with U-shaped sculptural lines, especially strong on the internal mould.

One of the two fragmentary thoracic segments present, probably the seventh, seems to have macropleurae (pl. 11, fig. 3). Articulating half ring very broad (sag.). Ring furrow broad (sag.) but rather shallow. Rachial ring with sculptural lines convex forwards on the specimen without macropleurae, but on the macropleural segment concave. Fulcral process low, longitudinally elongated. Anterior pleural band gently convex, posterior pleural band concave, giving rise to a sharply defined, ridge-like pleural furrow. Sculptural lines longitudinal on anterior pleural band, concave forwards on posterior pleural band. Dorsal furrow shallow.

Pygidium with rachis gently convex both longitudinally and transversely, and very rapidly tapering rearwards, producing a triangular shape. Articulating half ring very broad (sag.). Articulating ring furrow narrow and sharply defined. First rachial ring only slightly narrower at axial line than laterally, with strong sculptural lines being concave at mesial part, laterally running obliquely backwards inwards. Ring furrow narrow and sharply defined. Second rachial ring separated into two rounded triangular, elevated fields strongly granulated close to axial line, and with sculptural lines concave forwards and corresponding to those on the lateral parts of first rachial ring. Muscle scar shallow. Postrachial ridge sharply defined, keel-like and finely granulated. Fulcral process very low, longitudinally elongate. Dorsal furrow shallow. Interpleural furrow indicated by sculptural lines, which adaxially are directed transversely, but abaxially are directed obliquely forwards.

**Remarks.** - *S. angustilingua* obviously seems to be related to the other two species certainly belonging to the genus, *S. scripta* n. gen., n. sp. and *S. scriptoides* n. gen., n. sp., both from higher horizons in the Ampyx Limestone. It differs markedly from both in its very narrow glabellar tongue, very strongly concave forwards sculptural lines on the median area, and sharply defined keel-like postrachial ridge. Actually, the glabellar tongue is the narrowest of any known remopleurid. The closest condition is seen in the Ashgill species *Amphitryon radians* (Barrande, 1846) which, like *S. angustilingua*, also has an elongate hypostome with a triangular field separating the two oval areas; although the anterior part of this field is much more developed in *A. radians*. Furthermore, the rather short occipital furrow characterizes both forms. Unfortunately, the only pygidium known of *S. angustilingua* does not show the posterior part, but the preserved part is rather similar to *A. radians*, with the rachis tapering rapidly and interpleural furrows being present. The last character separates *S. angustilingua* from *S. scripta* and *S. scriptoides*, suggesting it to be the most likely ancestor of the Ashgill genus *Amphitryon*. All the above cited characters indicate a relationship between *Sculptella* and *Amphitryon*, which is more fully discussed on p. 288.

**Occurrence.** - Very common in some sandy beds and bioclastic beds in the lowermost part of the Ampyx Limestone and Shale, 4aβ, in Ringerike: Gomnes, Gullerud, Kullerud and Norderhov. Ampyx Limestone (probably lowermost part) in Oslo–Asker: Håkavik and Southern Kojatangen in Asker, Bygdøy in Oslo.

**Sculptella(?) nonscripta** n. gen., n. sp.

Pl. 13, figs. 4–13, text-fig. 8

**Name.** - From Latin *non*, not, and *scriptura*, a writing, referring to the almost smooth median area.
Holotype. – A well preserved and almost complete cranidium, PMO 74668. Coll. F. Nikolaisen, 1967. Pl. 13, figs. 6–9.

Type stratum and type locality. – Ampyx Limestone, 4aβ. Road section at Snarøyveien near Fornebu Airport, Snarøya, Bærum, Oslo–Asker.

Other material. – Several more or less fragmentary cranidia.

Diagnosis. – Median area almost two-thirds as long as wide, almost smooth. Glabellar tongue almost one-quarter as wide as median area, four-fifths as wide as long. Occipital furrow slightly more than two-fifths as wide as median area.

Description. – Cranidium 82% as long as wide, convex longitudinally, and with a rounded spade-shaped outline. Median area gently convex, 66% as long as wide, greatest width behind transverse mid-line, completely smooth or with a few short, wavy, transverse sculptural lines laterally and posteriorly, usually together with fine granulation, or only with granulation along lateral margins. Three pairs of lateral glabellar 'furrows' discernible as extremely faintly elevated fields, or, more commonly, as fields where the matrix is fixed to the test (cf. pl. 13, fig. 13). S1 moderately convex forwards, somewhat broader than S2, 26% as long as width of median area. S2 very gently convex forwards, 95% as long as S1. S3 very short, less than one-quarter as long as S1. Glabellar tongue gently convex transversely, 23% as wide as median area, 81% as wide as long, parallel-sided, and in some specimens with few convex forwards sculptural lines along axial line. Preglabellar furrow straight, faintly impressed but distinct. Preglabellar field gently convex transversely, longitudinally straight at axial line but concave laterally, of even width (sag.) or somewhat narrower at axial line, giving a concave anterior margin. Anterior pit low but distinct. Dorsal furrow narrow and shallow. Palpebral furrow rather deep anteriorly, becoming slightly shallower rearwards, and with a distinct postero-lateral bend. Anterior rim narrow, very gently convex and tapering slightly forwards. Palpebral rim relatively convex anteriorly, flattening rearwards, and being about half as wide at transverse mid-line as at postero-lateral corner, occasionally with subparallel, thin sculptural lines laterally and posteriorly. Occipital furrow 42% as wide as median area, deep, broad (sag.) and slightly convex forwards. Occipital ring rather convex transversely, very gently convex longitudinally, with distinct sculptural lines, sometimes also with small nodes posterior half part, and with posterior margin more or less strongly serrated. Occipital tubercle rather prominent, located close to occipital furrow. Posterior fixigena wedge-shaped, gently convex both transversely and longitudinally, and with anterior margin gently arched down.

Other parts of the trilobite unknown.

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Remarks. – S.(?) nonscripta bears a most striking resemblance to Remopleurides amphitryonoides Lu (1975, pp. 111–112, 302–303, pl. 4, figs. 16–18) from the Zone of Sinoceras chinense, upper part of Pagoda Limestone, south-western China. Lu, when establishing the species, includ-
ed it with some doubt in the genus *Remopleurides*, simultaneously emphasizing its apparent similarity to *Amphitryon*. He reported the glabellar tongue to be short, and he did not report any presence of a preglabellar field. It is possible that the anterior part of the glabellar tongue is broken off, which often occurs with specimens of the genus *Sculptella*. However, the test is somewhat thicker in *S. (?) nonscripta* than in other species undoubtedly belonging to *Sculptella* (cf. pl. 13, fig. 10). Judging from Lu’s illustrations, the test in the Chinese species seems to be very slightly thinner than in *S. (?) nonscripta*. *R. amphitryonoides* differs from the Norwegian species only in having a narrower glabellar tongue and longer median area. In the author’s opinion the Chinese species must be excluded from *Remopleurides*. Together with *S. (?) nonscripta* it should either be included in *Sculptella* or in a separate genus. Better and more complete material is needed of both species to confirm this.

The British species *Remopleurides salteri* Reed (1899, pp. 747–748, pl. 49, figs. 1–3) from the upper Llandeilo-lower Caradoc Tramore Limestone Formation of Ireland is also rather similar to *S. (?) nonscripta*, with the cranidium in Reed’s pl. 49, fig. 3 being strikingly close to some of the cranidia of the Norwegian species (cf. pl. 13, figs. 5 and 13). It differs only in having a shorter and wider glabellar tongue, and concentric sculptural lines on median area. It is highly probable that this British species should be included in a group together with *S. (?) nonscripta* and *Remopleurides amphitryonoides*, and thus excluded from the genus *Remopleurides amphitryonoides*. The stratigraphic positions of the three species certainly do correspond. *S. (?) nonscripta* may also be related to *S. scripta* n. gen., n. sp. (pp. 268–270, pl. 9, figs. 9–18) from the same beds and approximately the same horizon, as well as the slightly younger *S. scriptoides* n. gen., n. sp. (pp. 271–272, pl. 10, figs. 1–8). It differs from both in lacking the distinct sculptural pattern on the median area, and in having a broader glabellar tongue.

**Occurrence.** – Common in the middle and upper part of the Ampyx Limestone, 4aβ, and probably also present in the Cephalopod Shale in the northern districts of the Oslo Region. Oslo–Asker: Falbes gate, Lille Frøen and Merradalen in Oslo, road section at Snarøyveien near Fornebu Airport and south of Holtekilen in Bærum, Vollen, Gyssestad, between Arnestadstrand and Holmen, Elnestangen and Håkavik in Asker, and north-eastern side of Ildjernet in Nesodden. Ringerike: Gomnes and Ringsås. Cephalopod Shale (lower Kirkerud Group). Hadeland: 300 m south of Gran railway station.

### Genus *Sculptaspis* n. gen.

**Name.** – From Latin *sculptus*, carve, hew, cut, chisel, and Greek *aspis*, shield, referring to the densely sculptured cranidium.

**Type species.** – *Sculptaspis cordata* n. gen., n. sp., from upper part of Lower Chasmops Shale, 4ba, and Lower Chasmops Limestone, 4bβ, in the Oslo–Asker district.

**Diagnosis.** – A remopleurid genus with: the outline of cranidium like that of *Remopleurides*; median area with strong and closely spaced sculptural lines; three pairs of lateral glabellar furrows easily discernible as smooth fields interrupting the sculptural lines; glabellar tongue gently convex (tr.), less than one-third as wide as median area, preglabellar furrow distinctly defined; preglabellar field distinct, extending across anterior end of glabellar tongue; anterior pits not present; palpebral furrows strongly incised; librigena with a short, stout and distinctly curved genal spine, very narrow laterally, lateral margin of librigena proper and lateral margin of spine forms a blunt but distinct angle, posterior border furrow very broad (exsag.) but shallow; test very thick.


**Remarks.** – *Sculptaspis* seems to be related to *Sculptella* n. gen. (p. 265), a genus which has currently been found only in the upper Llandeilo-lower Caradoc Ampyx beds of the Oslo Region. The two genera may seem rather similar superficially, but a closer study shows the differences between them are sufficient to justify two separate genera. The glabellar tongue in *Sculptaspis* is narrower than in *Sculptella*, the
preglabellar furrow is distinctly defined, the librigena is much narrower laterally and has a short, curved genal spine with lateral margin distinctly angular to that of librigena proper. Also the test is much thicker in Sculptaspis, and the dorsal, palpebral, and occipital furrows are strongly incised. The two genera may have a common ancestor, probably among the Arenig forms discussed above. Possibly Sculptaspis should be included in the Remopleuriidiella-Remopleurella lineage (p. 266), but it does not, however, seem to fit as well as Sculptella. The genus may have branched from this lineage quite early in the Arenig or developed concurrently. Characters indicating an early separation are found in the librigenae and thickness of the test. In the librigena of Sculptaspis the lateral margin of genal spine is distinctly angular to the lateral margin of librigena proper, as opposed to both earlier and later forms of the Remopleuriidiella-Amphitryon lineage, which hardly have any angle laterally. Likewise, the test is considerably thicker in Sculptaspis than in the Arenig or late Caradoc members of this evolutionary lineage. That the group should develop a thick test and then return to a thin one, whilst simultaneously altering the shape of the librigenae before re-establishing the original shape, seems highly improbable. It seems more likely Sculptaspis represents a branch which did not give rise to any later genus. A less likely, but nevertheless possible, solution is that Sculptaspis and Sculptella have different ancestors. In that case a fairly possible ancestral genus of Sculptaspis is Robergiella s.l., a genus quite widespread in the Arenig. Species assigned to this genus and resembling Sculptaspis are R. striata (Endo, 1932) of South manchuria, Remopleuriidiella? khitica Chugaeva, 1973 of north-eastern U.S.S.R., Remopleurides nasutus Lu, 1957 and R. shihtzupuensis Lu, 1957 of central China, and Robergiella lunehukensis Fortey, 1980 of Spitsbergen.

The cephalon is the only part of the dorsal shield of Sculptaspis known with certainty. The thorax and pygidium described and figured by Hadding (1913, pp. 77–78, pl. 8, figs. 13–14) as Remopleurides sp. I and sp. II respectively, may well belong to Sculptaspis, thus indicating a pygidium with first pair of pleural spines reaching beyond tips of second pair as in Sculptella.

Species of this new genus are very easy to determine on the basis of the sculptural pattern on the median area. The pattern differs very little within each species, a feature similarly observed by Whittington (1959, p. 403) in Remopleurides caelatus. Widespread species like S. erraticca n. gen., n. sp. (pp. 279–281, pl. 12, figs. 1–7) should be excellent guide fossils because of their short vertical distribution. The specimens described by Hedström (1923, pp. 17–19, pl. 2, figs. 12–14) as Remopleurides dorsospinifer from a deep boring in Gotland may be a good Swedish example. The author has studied a cranidium from the Lunne Limestone in Jämtland, which represents a new species of Sculptella and which agrees with Hedström's material in every detail.

Other species of the genus seem to be very common in Llandeilo and lower Caradoc rocks of Sweden. They need to be studied in detail to enable a closer comparison with the Norwegian species, but one of them, Sculptaspis sexlineata (Angelin, 1851), which is common in the Skagen Limestone, also occurs in contemporaneous beds in Norway.

Sculptaspis is at present known with certainty only from Sweden, Estonia and Norway. The Irish species Remopleurides portlocki Reed (1899, pp. 746–747, pl. 49, fig. 4) may belong to the present genus (cf. p. 270) but is in need of revision, which is beyond the scope of this paper.

It is highly probable that this new genus is also represented in eastern North America. Remopleurides linguatus Ruedemann (1901, pp. 56–59, pl. 3, figs. 21–29) from the “Trenton Group” of New York, U.S.A., is remarkably similar to some species included in Sculptaspis, e.g. S. sexlineata (Angelin, 1851) and S. insculpta. The similarity to S. sexlineata was pointed out by Ruedemann when he erected the species, and he included it in the subgenus Caphya, which is a subjective synonym of Amphitryon. His reasons for doing so were the distinctly impressed lateral glabellar furrows and the gently convex median area. The descriptions and illustrations given by Ruedemann allow one to make closer comparison with Sculptaspis. Although Ruedemann did not suggest the presence of a preglabellar field, it is quite possible that a closer study will confirm the presence of such a feature. The librigena has a broad smooth field along the lateral margin as in Sculptaspis, but the even lateral margin of librigena proper and genal spine, together with the absence of a genal notch points towards genera like Remopleurella and Amphitryon. On the contrary, however, the strong fulcrum processes on the thoracic segments and possibly the strong granulation on the median area and occipital ring certainly deny such close affinities. The stratagra-
Fig. 9. Scultaspis cordata n. gen., n. sp.
Cranidium of holotype cephalon, pl. 11, figs. 5–8. Lower part of Lower Chasmops Limestone, 4bβ. Northern Langøy in Bunnefjorden, Nesodden, Oslo-Asker. PMO 5288. x 7.

Sculptaspis cordata n. gen., n. sp.
Pl. 11, figs. 5–12, text-fig. 9

Name. – From Latin cordatus, heart-shaped, referring to the pattern of the sculptural lines on the median area.

Holotype. – A well preserved cephalon lacking the right librigena, PMO 5288. Coll. W. C. Brøgger, ?. Pl. 11, figs. 5–8.

Type stratum and type locality. – Lower Chasmops Limestone, 4bβ. Northern Langøy in Bunnefjorden, Nesodden, Oslo-Asker district.

Other material. – One fragmentary cephalon on the same block as the holotype, four cranidia, and three fragmentary librigenae.

Diagnosis. – Median area rather convex, almost two-thirds as long as wide, with sculptural lines in cordate pattern mesially. Glabellar tongue less than one-fifth as wide as median area. Preglabellar field at axial line two-fifths as long as glabellar tongue. Occipital furrow less than half as wide as median area.

Description. – Cranidium oval in outline, rather convex, 84% as long as wide. Median area oval, rather convex, 66% as long as wide, widest across transverse mid-line, with sculptural lines thin, very closely spaced, and subcircular along margins but distinctly cordate at mesial part, and with distinct granulation laterally. The three pairs of lateral glabellar furrows discernible as narrow, smooth fields interrupting the sculpture. S1 convex forwards, 29% as long as width of median area. S2 somewhat thinner than S1, very gently convex forwards, very slightly longer than S1. S3 very short, slightly broader (exsag.) than S1 and 28% as long as this. Glabellar tongue goblet-shaped, very gently convex both transversely and longitudinally, 19% as wide as median area and 85% as long as wide, and with transverse or slightly convex forwards sculptural lines. Preglabellar furrow shallow but distinctly defined, strongly concave. Preglabellar field much wider (sag.) at axial line than laterally, length at axial line about 40% that of glabellar tongue, flattened mesially but convex laterally, and completely smooth. Anterior pit not observed. Dorsal furrow very deep and rather broad (tr.). Palpebral furrow very deep anteriorly, gradually becoming somewhat shallower rear-
wards, and with a very weak postero-lateral bend. Anterior rim very strongly convex (tr.), tapering forwards. Palpebral rim strongly convex anteriorly, flattening somewhat rearwards, and with sculptural lines running obliquely outwards forwards but not reaching lateral margin. Occipital furrow slightly convex forwards, very deeply incised, narrow and 44% as wide as median area. Occipital ring strongly convex transversely, moderately convex longitudinally, with strong sculptural lines parallel to transverse margins, and with postero-lateral margins coarsely serrated. Occipital tubercle small, located close to occipital furrow. Posterior fixigena parallel-sided (tr.), moderately convex both transversely and longitudinally, with anterior margin strongly arched down.

Librigena very narrow laterally, distinctly convex posteriorly, the angle with the surface of the eye being 150°, and provided with a short, flattened and distinctly curved spine. The length of the spine is less than half that of librigena proper, with a broad base forming an angle with lateral margin of librigena proper of 120°, and with fine closely spaced, longitudinal sculptural lines. Eye socle prominent, triangular in cross-section posteriorly, tapering rapidly forwards and dying out a short distance in front of transverse mid-line. Eye socle furrow strong and very deeply impressed posteriorly, tapering very rapidly forwards. Posterior border furrow coalesced with eye socle furrow at inner part, laterally very broad and shallow, directed obliquely outwards and slightly rearwards, and reaching genal notch. Postero-lateral corner blunt, strongly arched down. Genal notch very wide (tr.) but very shallow. Sculptural lines posteriorly concentric to the eye socle. Laterally from base of genal spine and forwards a broad smooth field. Eye anteriorly broad, gradually tapering rearwards. Doublure very strongly arched down along median suture. Terrace lines strong, with smaller sculptural lines in between.

Other parts of the dorsal shield unknown.

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Remarks. – The type species is very distinctive in its peculiar pattern of the sculptural lines on the median area. Probably the closest related species is the slightly older S. sexlineata (Angelin, 1851, p. 13, pl. 9, figs. 7-7a, this paper pp. 285-286, pl. 12, figs. 11-13, pl. 13, figs. 1-3) from Skagen Limestone of Sweden. Besides the different sculpture, S. sexlineata differs in having a more granulated median area, wider glabellar tongue, and a slightly wider occipital furrow.

Occurrence. – Upper part of Lower Chasmops Shale, 4bα, and Lower Chasmops Limestone, 4bβ. Oslo–Asker: Lindøya in Oslo (4bα) and Northern Langøy (4bβ) in Nesodden.

Sculptaspis erratica n. gen., n. sp.
Pl. 12, figs. 1-7, text-fig. 10

Name. – From Latin erratis, wanderer, referring to the wide distribution of the species.


Type stratum and type locality. – Ogygiocaris Shale, 4aα. Road section between Nydal and Furnes Church, Nes-Hamar district.

Other material. – One counterpiece of a fragmentary cephalon and fifteen cranidia.

Diagnosis. – Median area slightly more than two-thirds as long as wide, with U-shaped or almost V-shaped sculptural lines. Glabellar tongue almost one-third as wide as median area. Preglabellar field of even width (sag.), one-eighth as long as glabellar tongue. Occipital furrow slightly less than half as wide as median area.

Description. – Cranidium almost circular in outline, only slightly wider than long, moderately
Fig. 10. *Sculptaspis erratica* n. gen., n. sp.
Paratype cranidium, pl. 12, fig. 6. Ogygio-
caris Shale, 4aa. Road section between
Nydal and Furnes Church, Nes-Hamar.
PMO 67194. × 8.

Convex. Median area oval, moderately convex,
69% as long as wide, widest across transverse
mid-line, sculptural lines fine and closely spaced,
strongly U-shaped or in some specimens almost
V-shaped, and with small but closely spaced
nodes along lateral margins. The three pairs of
lateral glabellar furrows are extremely gently im-
pressed but much more easily seen as smooth
stripes interrupting the sculpture. S1 moderately
convex forwards, 25% as long as width of me-
dian area, relatively broad (exsag.). S2 very gen-
tly convex forwards, very thin and as long as S1.
S3 short, broader (exsag.) than S2 and 33% as
long as this. Glabellar tongue gently convex both
transversely and longitudinally, 31% as wide as
median area, 75% as long as wide, gently taper-
ning forwards, with sculptural lines transverse or
slightly concave forwards close to anterior mar-

**Dimensions.**

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**Remarks.** The most similar, and probably also
closest related form is an undescribed species
with sculptural lines of similar pattern on the
median area. It occurs in the Skagen Limestone
(lower Caradoc) in Sweden, and thus is consider-
bly younger than *S. erratica*. Although the
sculptural pattern is similar in the Skagen Lime-
stone species, it may be separated by being
coarser and less closely spaced. Additionally the

Swedish species has a distinctly wider glabellar
tongue.

Two Norwegian species, one slightly younger
and one of about equal age, may be related to *S.
erratica*. *S. pannucea* n. gen., n. sp. (pp. 282–
283, pl. 12, figs. 8–10) from Ampyx Limestone in
the Oslo–Asker district has very much the same
proportions as in *S. erratica*, but is easily separat-
ed by having the sculptural lines on median area
only slightly concave. This character also separates *S. insculpta* n. gen., n. sp. (pp. 281–282, pl. 11, figs. 13–17) from Ogygiocaris Shale in the Oslo–Asker district, which is distinguished by a narrower glabellar tongue and a distinct granulation on the median area.

The remopleurid material from a deep boring at Visby, Gotland in Sweden, described and figured by Hedström (1923, pp. 17–19, pl. 2, figs. 12–14) as *Remopleurides dorsospinifer*, as earlier pointed out by Reed (1952, pp. 108–109) does not belong to that species. As mentioned above (p. 277), a specimen from Lunne Limestone (approximately equal to Seby Limestone = upper Llanvirn) in Lunne, Jämtland in Sweden, agrees to the finest detail with the cranidium described and figured by Hedström, and represents a new species of *Sculptaspis*. This new species may be related to *S. erratica*. It differs in having a V-shaped sculptural pattern on the median area which joins at the anterior slope to form ellipsoidal figures, and, as opposed to *S. erratica*, the sculptural lines on the palpebral rims are directed abaxially obliquely rearwards. The glabellar tongue is also shorter and less steeply arched down in the Swedish species.


*Sculptaspis insculpta* n. gen., n. sp.

Pl. 11, figs. 13–17, text-fig. 11

- 1887 Remopleurides sp. – Brøgger, p. 16 (Recorded).

**Name.** – From Latin *insculptus*, engraved, referring to the strong sculpture on the cranidium.

**Holotype.** – A well preserved but somewhat fragmentary cranidium, PMO 3663. Coll. ?. Pl. 11, figs. 13–16.

**Type stratum and type locality.** – Ogygiocaris Shale, 4aa3. Hukodden, Bygdøy in Oslo.

**Other material.** – Twelve cranidia.

**Diagnosis.** – Median area about two-thirds as long as wide, with sculptural lines concave forwards. Glabellar tongue less than one-quarter as wide as median area. Preglabellar field at axial line one-fifth as long as labellar tongue. Occipital furrow almost two-fifths as wide as median area.

**Description.** – Cranidium 92% as long as wide, moderately convex both longitudinally and transversely. Median area oval, 70% as long as wide, widest slightly behind transverse mid-line, moderately convex, sculptural lines strong and very closely spaced, concave forwards at mesial part, laterally almost perpendicular to margins and with distinct granulation all over but strongest along lateral parts. The three pairs of lateral glabellar furrows are very gently impressed but more easily seen as smooth fields parallel to the sculptural lines. S1 gently convex forwards, slightly thinner than S1 and slightly longer than this. S3 slightly longer than usual for species of this genus, as broad (exsag.) as S1 and 30% as long as this. Glabellar tongue very gently convex, almost flattened, 23% as wide as median area, 91% as long as wide, slightly tapering forwards, and with sculptural lines becoming successively more and more convex forwards. Preglabellar field very slightly convex (sag.), slightly broader at axial line than laterally, and 20% as long as glabellar tongue. Anterior pit not observed. Dorsal furrow narrow but very deeply incised. Palpebral furrow very deep anteriorly and laterally, slightly shallower posteriorly, and with postero-lateral bend very gently impressed. Anterior rim gently convex (tr.), ridge-like. Palpebral rim strongly convex anteriorly, gradually

![Fig. 11. Sculptaspis insculpta n. gen., n. sp. Holotype cranidium, pl. 11, figs. 13–16. Ogygiocaris Shale, 4aa3, Hukodden, Bygdøy in Oslo. PMO 3663. × 8.](image-url)
flattening slightly rearwards, and with sculptural lines directed abaxially obliquely forwards. Occipital furrow very deep, straight, and 38% as wide as median area. Occipital ring rather convex transversely, slightly more convex longitudinally than in other species of the genus, with strong, slightly wavy, transverse sculptural lines, and with postero-lateral margins moderately serrated. Occipital tubercle small but prominent, located very close to occipital furrow. Posterior fixigenae not well preserved in present material. Other parts of the trilobite unknown.

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Remarks. – S. insculpta seems to be related to the considerably younger S. sexlineata (Angelin, 1851, p. 13, pl. 9, figs. 7-7a) from the lower Caradoc Skagen Limestone of Västergötland in Sweden, a species which also occurs in the lower part of the Lower Chasmops Shale in the Oslo–Asker district. S. insculpta differs from this in having a longer median area with more transversely directed sculptural lines, less convex S₁ and more parallel-sided glabellar tongue. However, the two species are so similar in main characters that it seems most likely that S. insculpta may be a precursor of S. sexlineata.

The cranidium of Remopleurides linguatus Ruedemann (1901, pp. 56–59, pl. 3, figs. 21–29) from the “Trenton Group” of New York, U.S.A., is remarkably similar to that of S. insculpta, but differs in having a more convex median area, longer glabellar tongue, and transverse, scarcer sculptural lines. As pointed out above (p. 277) R. linguatus may belong to Sculptaspis.

The cranidium of the type species S. cordata n. gen., n. sp. (pp. 278–279, pl. 11, figs. 5–12) has a somewhat similar shape and a similar granulation on lateral parts of median area. However, it is easily distinguished by the cordate sculptural pattern on median area, the narrower glabellar tongue, and much broader (sag.) preglabellar field, and the relationship therefore seems to be quite remote.

The transverse sculptural lines together with distinct granulation on the median area immediately distinguishes S. insculpta from the approximately contemporaneous S. erratica n. gen., n. sp. (pp. 279–281, pl. 12, figs. 1-7).

Occurrence. – Ogygiocaris Shale, 4aa3, Oslo–Asker: Bygdøy in Oslo, between Sjøstrand and Hagebukta, and Elnestangen in Asker.
Fig. 12. *Sculptaspis pannucea* n. gen., n. sp. Holotype cranidium, pl. 12, figs. 8-10. Upper part of Ampyx Limestone, 4aβ. Islet at Vollen in Asker. PMO 74687. × 8.

wide as median area and slightly longer than wide, slightly tapering forwards, and with distinctly convex forwards sculptural lines. Preglabellar furrow gently impressed, slightly convex forwards. Preglabellar field distinctly broader at axial line than laterally, smooth and slightly concave (sag.). Anterior pit not observed. Dorsal furrow narrow and well defined. Palpebral furrow deep anteriorly and laterally, slightly shallower posteriorly, and with postero-lateral bend shallowly impressed. Anterior rim narrow and convex (tr.). Palpebral rim convex anteriorly, rapidly flattening rearwards, distinctly arched down in lateral view, and with sculptural lines directed abaxially obliquely forwards. Occipital furrow gently convex, deep and strong, and 40% as wide as median area. Occipital ring strongly convex transversely but almost flat longitudinally, with sculptural lines strongly convex forwards, and with postero-lateral margins moderately serrated. Occipital tubercle small, located close to occipital furrow. Posterior fixigena poorly preserved, apparently quite convex transversely. Other parts of the trilobite unknown.

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**Remarks.** – This new species may be related to the somewhat older *S. erratica* n. gen., n. sp. (pp. 279–281, pl. 12, figs. 1–7) as pointed out above (p. 280).

*S. psammius* (Opik, 1937, pp. 20–21, pl. 17, fig. 8) from Idavere beds (= upper Llandeilo-lower Caradoc) of Estonia is probably also related to *S. pannucea*. It differs in having a narrower cranidium, wider glabellar tongue, and rearwardly convex sculptural lines on the occipital ring. The granulation on the median area also seems to be coarser and more densely spaced in *S. psammius*. The gently concave sculptural lines on the median area of *S. pannucea* recall those of the older *S. insculpta* n. gen., n. sp. (pp. 281–282, pl. 11, figs. 13–17) and the younger *S. sexlineata* (Angelín, 1851, this paper pp. 285–286, pl. 12, figs. 11–13, pl. 13, figs. 1–3), but they are coarser and less closely spaced. Furthermore, the cranidium of *S. pannucea* is distinctly separated from these two species by lacking granulation on the occipital ring, and in having the palpebral rims much stronger arched down in lateral view.

Finally, the cranidium figured by Funquist (1919, pl. 2, figs. 5–5a) as *Remopleurides subquadratus* from somewhat younger beds of Scania, Sweden, has a similar pattern of the sculptural lines on the median area, but differs distinctly in having a much wider glabellar tongue. However, the specimen does not belong to *S. subquadratus*, but is much closer to *Remopleurides latus* Olin, 1906.

**Occurrence.** – Upper part of Ampyx Limestone, 4aβ. Oslo–Asker: Islet at Vollen in Asker.

*Sculptaspis impolita* n. gen., n. sp.

Pl. 12, figs. 14–18, text-fig. 13

**Name.** – From Latin *impolitus*, unpolished, rough, referring to the sculptured median area.


**Type stratum and type locality.** – Lower Chasmops Shale, 4bα. Railroad section west of Billingstad Station in Asker, Oslo–Asker district.

**Other material.** – Six cranidia and one poorly preserved librigena.
Fig. 13. *Sculptaspis impolita* n. gen., n. sp. Holotype cranidium, pl. 12, figs. 12–15. Lower Chasmops Shale, 4ba. Railroad section west of Billingstad Station in Asker. PMO S. 1944. × 10.

**Diagnosis.** – Median area subcircular, with sculptural lines strongly U-shaped. Glabellar tongue less than one-fifth as wide as median area, as long as wide. Occipital furrow almost half as wide as median area.

**Description.** – Cranidium almost circular in outline, 97% as long as wide, gently convex both transversely and longitudinally. Median area subcircular in outline, very gently convex, 83% as long as wide, with very fine, closely spaced, strongly U-shaped sculptural lines, and with small nodes scattered all over but mostly concentrated laterally. The three pairs of lateral glabellar furrows are almost invisible in the present material, but a small well preserved fragment shows S3 as smooth fields as in several other species of the genus. Glabellar tongue gently convex, 18% as wide as median area and as long as wide, tapering forwards to become goblet-shaped in frontal view, test poorly preserved. Preglabellar furrow strongly impressed, slightly concave. Preglabellar field slightly broader at axial line than laterally, at axial line 28% as long as glabellar tongue, flat or slightly convex (sag.) at axial line, laterally slightly concave. Anterior pit not observed. Dorsal furrow deep and broad. Palpebral furrow very deep anteriorly and laterally, posteriorly slightly shallower, with postero-lateral bend very shallow. Anterior rim flattened, tapering rapidly forwards. Palpebral rim roughly triangular in cross-section anteriorly, gradually flattening rearwards. Occipital furrow straight, deep and strong, 43% as wide as median area. Occipital ring moderately convex transversely, flat longitudinally, with transverse sculptural lines, and with strong granulation. Occipital tubercle large and prominent. Posterior fixigenae poorly preserved in material present.

One very poorly preserved librigena most probably belonging to this species is present. The specimen is exfoliated, but shows the librigena to be very narrow latero-laterally and with a stout spine with lateral margin distinctly angular to that of librigena proper. Postero-lateral corner rounded and not prominent. Genal notch large but shallow. Doulbre with junction between median and hypostomal suture produced into a deep projection as known in the type species (cf. p. 279, pl. 11, fig. 9). Pit located closer to anterior margin than to hypostomal suture.

**Remarks.** – *S. impolita* seems to have its closest relative in the type species, *S. cordata* n. gen., n. sp. (pp. 278–279, pl. 11, figs. 5–12) from upper part of Lower Chasmops Shale and Lower Chasmops Limestone. It differs from this in having a much more circular-shaped cranidium and in having a completely different sculptural pattern on median area.

*Remopleurides circularis* Hadding (1913, p. 77, pl. 8, fig. 12), herein included in *Sculptaspis*, from the considerably older *Ogygiocaris* Shales of Andersön, Jämtland in Sweden, has similar cranidial proportions as *S. impolita*. The specimen of Hadding is unfortunately rather poorly preserved and does not possess any traces of sculptural lines on the median area. A closer comparison is therefore impossible.

**Occurrence.** – Lower Chasmops Shale, 4ba. Ringerike: Jevnaker–Norderhov–Åra road junc-
Sculptaspis sexlineata (Angelin, 1851)

Pl. 12, figs. 11–13, Pl. 13, figs. 1–3, text-fig. 14

1851 Remopleurides 6-lineatus n. sp. – Angelin, p. 13, pl. 9, figs. 7–7a (Short diagn. and figs. of cephalon). □ 1854 Brachypleura 6-lineata Ang. – Angelin, add. p. □ 1869 Remopleurides sexlineatus Ang. – Linnarsson, p. 69 (Recorded and discussion). □ 1878 Remopleurides 6-lineatus n. sp. – Angelin, p. 13, pl. 9, 7–7a (Short diagn. and figs. of cephalon), reedition of Angelin 1851 and 1854 by G. Lindström. □ 1906 Remopleurides sexlineatus Ang. – Olin, p. 55, pl. 2, figs. 3–4 (Recorded and figs. of cranium and librigena). □ 1953 Remopleurides sexlineatus (Ang.) – Lindström, p. 131, figs. 6a–c (Recorded and figs. of thoracic segm., librigena and pygidium).

Holotype (by monotypy). – A relatively well preserved cephalon figured by Angelin 1851, pl. 9, figs. 7–7a, catalogue number IPU Ar. 13504, this paper Pl. 13, figs. 1–2.

Type stratum and type locality. – Skagen Lime­stone. Mossen Bentonite Quarry, Kinnekulle, Västergötland, Sweden.

Norwegian material. – Nine cranidia and one very fragmentary librigena.

Diagnosis. – Median area three-fifths as long as wide, with sculptural lines gently concave forwards. Glabellar tongue one-quarter as wide as median area. Preglabellar field one-fifth as long (sag.) as glabellar tongue. Occipital furrow almost half as wide as median area.

Description. – Cephalon strongly convex, oval in outline (genal spines excluded). Median area rather convex, oval, 62% as long as wide, with very closely spaced sculptural lines concave forwards at middle part but somewhat disarranged laterally, and with distinct granulation all over but mostly concentrated laterally. The three pairs of lateral glabellar furrows are easily discernible as smooth fields interrupting the sculpture. S1 strongly convex forwards, 28% as long as width of median area. S2 almost straight, 33% as long as width of median area. S3 elongate, 28% as long as S2. Glabellar tongue very gently convex, 24% as wide as median area and 78% as long as wide, distinctly tapering forwards, and with distinct, slightly convex forward sculptural lines, sometimes also with scattered nodes. Preglabellar furrow narrow but well defined, shallow and slightly convex. Preglabellar field 20% as long as glabellar tongue, flat, smooth, and of even width (sag.). Anterior pit not observed. Dorsal furrow deep. Palpebral furrow very deep, with postero-lateral bend shallowly impressed. Anterior rim gently convex, very slightly tapering forwards. Palpebral rim strongly convex anteriorly and laterally, posteriorly slightly more flattened, and with sculptural lines directed abaxially forwards. Occipital furrow very deep, almost straight, and 48% as wide as median area. Occipital ring moderately convex both transversely and longitudinally, with strong, transverse sculptural lines and strong, distinct granulation; postero-lateral margins strongly serrated. Occipital tubercle small. Posterior fixigena strongly convex both transversely and longitudinally, with anterior margin strongly arched down.

Librigena very narrow laterally, convex posteriorly, the angle with eye being laterally 160°, and provided with a short curved spine; length of the spine being about half that of librigena proper, with broad base forming an angle with lateral margin of librigena proper of 145°, and with fine, closely spaced, longitudinal sculptural lines. Eye
socle roughly triangular in cross-section posteriorly, rapidly tapering forwards and dying out slightly in front of transverse mid-line. Eye socle furrow strong and very deeply impressed posteriorly, tapering very rapidly forwards. Posterior border furrow coalesced with eye socle furrow at inner part, laterally broad and shallow, reaching genal notch. Postero-lateral corner blunt, very strongly arched down. Genal notch very wide (tr.) and rather shallow. Sculptural lines posteriorly concentric to the eye socle. From base of genal spine and forwards a broad, smooth field along lateral margin. Doublure very strongly arched down along median suture, forming a keel-like feature. Other parts of the doublure not sufficiently preserved.

Other parts of the dorsal shield not known with certainty.

**Remarks.** – The two works of Angelin (1851, 1854) treating Scandinavian trilobites were reprinted jointly in 1878 edited by G. Lindström. In the preface to this reprint Lindström states 1852 as the year of publication of the first work. This has caused some confusion by later authors concerning the correct year. Subsequently Westergård (1910, p. 4, footnote) points out that the year given by Lindström is false. His only argument is that the year on the cover of Angelin’s original paper is 1851. The present author has not found the decisive solution to this problem, but follows common practice giving the year of publication as 1851.

The remopleurid material from Lower Chasmops Beds of Fågelsång district in Scania, Sweden, figured by Lindström (1953, fig. 6) as Remopleurides sexlineatus, does not include any cranidia. An accurate determination of the material is therefore impossible at present. The short genal spine and wide genal notch of the figured librigena point towards the genus Sculptaspis. The author has not seen any pygidia referable to Sculptaspis, and thus it is unreasonable to include the pygidium of Lindström definitely in this genus. The pygidium strongly recalls those of certain species of the contemporaneous genus Remopleurides, especially those of the species occurring in the Lower Chasmops Beds of Norway, e.g. R. affluens n. sp. (cf. pl. 2, figs. 4–6, pl. 3, fig. 12 and pl. 4, fig. 16). But it must be pointed out that librigenae of Scandinavian lower Caradoc species of Remopleurides have short genal spines, with lateral margin angular to that of librigena proper, not unlike those of Sculptaspis.

As pointed out above (p. 279) S. sexlineata seems to be closely related to the type species S. cordata n. gen., n. sp. from slightly younger strata. The two species have similar cranidial proportions, as well as distinct granulation on the median area (slightly stronger in S. sexlineata) and occipital ring, but the pattern of the sculptural lines on the median area immediately separates them. A quite similar pattern of the sculptural lines on the median area is found in the considerably older S. insculpta n. gen., n. sp. (for further details see p. 282).

Remopleurides linguatus from the “Trenton Group” of New York, U.S.A., was erected by Ruedemann (1901, pp. 56–59, pl. 3, figs. 21–29). In doing so he pointed out its similarity to S. sexlineata. Its cranidium differs from that of S. sexlineata in having a wider glabellar tongue, transverse and more scarce sculptural lines on the median area, and an even margin of librigena proper and genal spine. R. linguatus should probably be assigned to Sculptaspis as mentioned above (p. 277).

**Occurrence.** – Lower part of Lower Chasmops Shale, 4ba. Oslo–Asker: Road section at Økernveien, Ullern Mill and Oscarshall in Oslo, road junction Skogveien–Løvenskiolds vei at Jar, Gyssestad and Slependen in Bærum. Sweden: Skagen Limestone.

**Sculptaspis** sp.

Pl. 13, figs. 16–17

**Material.** – One incomplete cranidium, one early holaspid cranidium, and one small librigena, all with counterparties.

**Description.** – Median area with distinctly impressed lateral glabellar furrows. Palpebral furrows strongly incised. Ornamentation on median
area of concentric sculptural lines anteriorly and laterally, together with a few nodes at lateral parts. Librigena with long and slender, slightly curved, genal spine, with a lateral margin which is even with that of librigena proper. Genal notch very deep, or perhaps more correctly the base of the genal spine is located quite far forwards. Eye socle furrow very deep and broad posteriorly.

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**Remarks.** – The material is preserved in shale and strongly flattened, and does not permit a detailed description. The early holaspid cranidium agrees well with that of *S. erratica* n. gen., n. sp. (p. 279, pl. 12, fig. 7), and the librigena is comparable in size. The very large genal notch is also found in young stages in silicified material of *Remopleurides* described by Whittington (1959), whereas larger specimens may have the base of the genal spine located further backwards. The fact that the librigena present is a younger stage is probably the reason for the even lateral margin of librigena proper and spine.

The median area of this species has sculptural lines comparable to those described for *Remopleurides salteri* Reed (1899, pp. 747–748, pl. 49, figs. 1–3) from the somewhat younger Tramore limestone Formation of Ireland, a species here regarded as possibly belonging to *Sculptella* n. gen. The poor preservation of the Norwegian material of *S. sp.* does not, however, allow any closer comparison.


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**Genus Robergiella** Whittington, 1959

**Type species.** – By original designation of Whittington, 1959 (pp. 431–432). *Robergiella sagittalis* Whittington, 1959, from lower part of the Edinburg limestone, east of Lacey Spring Post Office, Rockingham County, Virginia, U.S.A.

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**Robergiella? sp.**

Pl. 13, figs. 18–19


**Description.** – Median area 60% as long as wide, gently convex, with large and conspicuous nodes concentrated laterally and posteriorly. Lateral glabellar furrows extremely faint, only discernible due to difference in colour. Sculptural lines not present. Glabellar tongue 45% as wide as median area, rather convex (tr.), slightly increasing forwards, and covered with closely spaced but very small nodes. Preglabellar furrow strongly impressed. Preglabellar field broken off in the present specimen. Dorsal furrow and palpebral furrow deeply impressed. Palpebral rims strongly convex (tr.). Occipital furrow 40% as wide as median area. Occipital ring broken off.

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**Remarks.** – The present cranidium is remarkably similar to those described and figured as *Remopleurides* sp. by Dean 1973 (pp. 15–16, pl. 3, figs. 5, 8) from the Keele Range in north-western Yukon Territory in Canada, and also to those described and figured by Fortey 1980 (p. 46, pl. 5, figs. 9, 12–14, 16) as *Robergiella lundehukensis* from the Valhalla Formation of Spitsbergen. The age of both the Keele Range and the Spitsbergen material is regarded as being late Arenig-lower Llanvirn, and corresponds perfectly well with the age of *R.? sp.* The Helskjær Shale and Limestone is approximately contemporaneous with the upper part of the slightly more northern Stein Limestone (= "Orthoceratite Limestone"), which is part of the Caledonian allochton north
of and in the northern part of the Oslo Region. Studies on the conodont fauna of these deposits by Kohut (1973) has shown that the upper part most probably corresponds to the graptolite zone of Didymograptus bifidus and thus of Middle Ordovician age as in the sense taken herein. Other trilobites with strong North American–Arctic affinities have been previously reported from these and slightly younger strata as well as Helskjær Shale and Limestone, i.e. a form very close to Carolinities recorded by Nikolaisen (1962) and Cybelurus (Pliomerops sp. of Nikolaisen 1961 and Miracybele of Nikolaisen 1968), strengthening the assumption that R.? sp. is related to either the Canadian or the Spitsbergen form. Certainly the material known hitherto is too scarce and poorly preserved to fully clarify this interesting matter, but it is to be hoped that satisfactory material will be found during future collecting.

The present cranidium clearly deviates from the young holaspid cranidium of Sculptaspis erraticus n. gen., n. sp. (cf. pl. 12, figs. 7) from slightly younger beds in the succession at the same outcrop in having a wider median area, a broader glabellar tongue, and a coarser granulation on lateral parts of median area.

Occurrence. – Helskjær Shale and Limestone. Nes-Hamar: Road section between Nydal and Furnes Church.

Genus Remopleurella Dean, 1963

Type species. – By original designation of Dean, 1963 (pp. 249–250), Remopleurides burmeisteri Bancroft, 1949, from the zone of Onnia superba, Onnian Stage (upper Caradoc), north bank of River Onny, west-south-west of Winstanlow church, South Shropshire, England.

Diagnosis (Dean 1963, emend.) – Cranidium of typical remopleurid outline; median area only gently convex, both transversely and longitudinally, with three pairs of deeply-incised glabellar furrows, those of the first pair noticeably shorter (tr.) than those of the two other pairs, surface of test with conspicuous pattern of transverse, thin, raised lines; glabellar tongue convex (tr.), expanding forwards; preglabellar field present, extending across (tr.) anterior margin of glabellar tongue; occipital ring with even posterior margin; librigenae narrow antero-laterally, with genal spine arising from the genal angle, and with a smooth field extending along lateral margin of both librigena proper and genal spine; hypostome as long as, or somewhat longer than, broad, with median boss large, oval-shaped, oval areas gently convex, converging backwards axially; thoracic segments with posterior margin of rachial rings even, pleurae gently convex, with low fulcral processes; pygidium with convex, rapidly tapering rachis, distance from rachial end to axial end about as long as length of rachis, pleural field flattened, distinct interpleural furrows present, first pair of pleural spine extending beyond tips of much smaller second pair.

Remarks. – As discussed in connection with Sculptella n. gen. (p. 266), the author is convinced that Remopleurella represents one of two terminal genera in an evolutionary line drawn from Remopleuriella through Sculptella. Undoubtedly Remopleurella is very closely related to Amphitryon, as previously pointed out by Whittington 1966 (p. 74). In some morphological respects Remopleurella seems to occupy an intermediate position between Sculptella and Amphitryon, although the similarity to Amphitryon is greater than to Sculptella, as would be expected when considering the stratigraphical occurrence of these genera. In Remopleurella the genal notch has disappeared as opposed to the early representatives in this evolutionary lineage, which had the base of the genal spine located far forward (cf. text-fig. 3). The base of the spine, when gradually drawn rearwards has caused the outline of the librigenae found in Remopleurella (and Amphitryon). Simultaneously the pygidium has been reduced from five segments to only two, with an increase in distance between the rachial and axial ends, which continues after the reduction to two segments. Whether Remopleurella is a valid genus or a junior subjective synonym of Amphitryon has been discussed by Whittington (1966, p. 74), who argued that the cranidia are alike as well as the hypostomes. That is correct only when considering the material of R. burmeisteri (Bancroft, 1949) figured by Dean (1963, pl. 46, figs. 6, 8, 9, 11, 12, non pl. 45, fig. 2). Later Dean (1974) described the new species Remopleurella impressa (pp. 77–79, pl. 31, figs. 3, 4, 6, 8–11, pl. 33, figs. 10, 14) and the undoubtedly synonymous Remopleurides sculptilis (pp. 74–75, pl. 32, figs. 5, 7, 12, pl. 44, figs. 8, 10, 11), based on far better material than that of R. burmeisteri. He argued that the very wide
glabellar tongue and lack of preglabellar field, together with the much narrower librigenae, separates the genus from Amphi­tryon. The excellently preserved Norwegian material of the genus has revealed that his assumption concerning the preglabellar field was incorrect; it is also present in Remopleurella, although being very narrow at the axial line. Furthermore, as pointed out by Whittington (1966, p. 72, text-fig. 4c), one librigena of the Czech species A. radians (Barrande, 1846), has an unusually narrow antero-lateral part. It seems possible that this libri­gena represents an atavistic case. Despite all similarities between the two genera, the present author considers that Remopleurella represents a valid genus. One of the species of Sculptella, i.e. S. angustilingua n. gen., n. sp. (pp. 272-274, pl. 10, figs. 9-17, pl. 11, figs. 1-4) possesses a very narrow glabellar tongue not unlike that of Amphi­tryon. This species has also other conspicuous similarities to Amphi­tryon as pointed out above (p. 274), and should perhaps be considered the most likely ancestral species of Amphi­tryon. Stratigraphically Remopleurella appears just before Amphi­tryon and it is likely that it represents a separate branch to Amphi­tryon and has developed from one of the species of Sculptella other than S. angustilingua. The cranidia of the different species involved are easy to assign to their respective genus, and at present no intermediate form of the two concerned genera is reported.

Remopleurides sculptilis Dean, 1974 is based on pygidia and detached thoracic segments. When establishing the species, Dean hesitatingly referred it to the genus Remopleurides. He was probably aware of the possibility that it could be referred to Remopleurella and he rated its likeness to Amphi­tryon. The material, on which Remopleurides sculptilis is based, is very similar to the present Norwegian material of Remopleurella burmeisteri, and leaves little doubt about the generic position. The Chair of Kildare Lime­stone of eastern Ireland, type stratum of R. sculptilis, also yields cranidia of Remopleurella impressa, a remopleuridid definitely not belonging to Remopleurides. There seems little doubt that R. sculptilis is synonymous with R. impressa.

Following simple priority, Remopleurides sculptilis should be regarded as the senior synonym on basis of its precedence of position in the work in question.

The hypostomes figured by Apollonov (1974, pl. 21, figs. 2-3) as Remopleurella sp. from beds high up in the Ashgill of Kazakhstan. U.S.S.R., are more similar to that of Remopleurella than that of Amphi­tryon, indicating that Remopleurella may be quite widespread as well as having a long stratigraphical range.

Remopleurella burmeisteri (Bancroft, 1949)

Pl. 14, figs. 1–18

☐ 1945 Remopleurides (?Caphya) sp. – Lamont, p. 118 (Listed).
☐ 1949 Remopleurides burmeisteri n. sp. – Bancroft, pp. 300–301, pl. 10, figs. 19–20 (Descr. and figs. of cranidium and librigena).
☐ 1963 Remopleurella burmeisteri (Bancroft) – Dean, pp. 250–251, pl. 46, figs. 6, 8–9, 11–12, non pl. 45, fig. 2 (Descr. and figs. of lectotype cranidium, cranidium, librigena, thoracic segments, and hypostome).
☐ 1979 Remopleurella sp. nov. A – Bruton & Owen, pp. 216, 218 (Recorded).
☐ 1981 Amphi­tryon? sp. A – Owen, p. 17, pl. 3, fig. 16 (Short remarks and fig. of cranidium).

Lectotype. – A cranidium figured by Bancroft 1949, pl. 10, fig. 19, refigured by Dean 1963, pl. 46, fig. 11. BM In 42106.

Type stratum and type locality. – Zone of Onnia superba, Onnian Stage (upper Caradoc). North bank of River Onny, 655 m west-south-west of Wistanstow church, South Shropshire, England.

Norwegian material. – More than forty cranidia, four librigenae, seven hypostomes, three detached thoracic segments, two pygidia, and one meraspid cranidium.

Description. – Cranidium spade-shaped in outline, 98 % as long as wide, gently convex longitudinally, flattened transversely. Median area oval, 67 % as long as wide, greatest width just behind transverse mid-line, very gently convex both transversely and longitudinally, with very conspicuous sculpture of raised lines from forwardly tilted, roofstone-like lamellae. The pattern of the sculptural lines varies a little among different specimens, from strongly concave forward to almost transverse at the mesial part, always strongly arched backwards close to lateral margins, more or less disarranged mesially, and with density varying from ten to twenty-two lines per mm.
Three pairs of rather distinctly impressed lateral glabellar furrows are present. S1, the most strongly impressed, moderately convex forwards, 26% as long as width of median area. S2 very narrow, slightly impressed, very slightly convex forwards and as long as S1. S3 very gently impressed, strongly oblique, straight and 27% as long as S1. Glabellar tongue rather convex transversely, gently convex longitudinally, sloping obliquely downwards forwards at an angle of 120°. 41% as wide as median area at base, distinctly expanding forwards to become about twice as wide as long, anterior margin distinctly convex, and with slightly convex forwards sculptural lines of slightly varying density. Preglabellar furrow convex, distinctly defined. Preglabellar field forming an angle of about 120° with the glabellar tongue, flattened, considerably wider laterally than at axial line, and with a few sculptural lines subparallel to those on glabellar tongue. Dorsal furrow shallow and narrow. Palpebral furrow shallow, with the postero-lateral bend shallowly impressed. Anterior pit not present. Anterior rim gently convex (tr.), narrow and tapering forwards. Palpebral rim very narrow anteriorly, very rapidly expanding rearwards to become four times as wide posteriorly as anteriorly, very gently convex, sloping gently downwards inwards, and with distinct sculptural lines running obliquely abaxially forwards. Occipital furrow narrow (sag.) and shallow, very slightly convex, 38% as wide as median area. Occipital ring gently convex transversely, almost flat longitudinally, lateral margin even and unserrated, and with distinctly convex forwards sculptural lines of somewhat varying density. Occipital tubercle very small but distinct, located very close to occipital furrow. Posterior fixigena wedge-shaped, flattened both transversely and longitudinally, anterior margin not arched down.

Eye semi-annular, broadest anteriorly but tapering gently rearwards, composed of numerous small and closely set lenses. Librigena triangular, narrow anteriorly but rapidly widening rearwards, the angle with the surface of the eye 130°, anteriorly slightly concave (tr.), laterally gently convex, and provided with a long and slender genal spine, with a lateral margin which is even with that of librigena proper, its length being equal to that of librigena proper. Eye socle large, gently convex, of even width, and extending from anterior facial suture to posterior facial suture. Eye socle furrow shallow. Posterior border furrow almost completely effaced. Genal notch absent. Sculptural lines distinct, subconcentric to the eye socle on librigena proper, longitudinal on genal spine, and with a narrow, smooth field along the lateral margin of both librigena proper and spine. Doublure not properly known.

Hypostome convex transversely, gently convex longitudinally, 87% as wide as long, widest across transverse mid-line. Middle body separated from borders by narrow and shallow furrows anteriorly and laterally, posteriorly by a very broad (sag.) and very shallow furrow. Anterior margin strongly convex. Anterior wing short and strongly arched down. Shoulders very gently pronounced. Postero-lateral projection short but sharply defined. Posterior wing narrow, steeply arched down. Posterior border narrow at axial line, strongly expanding laterally to form triangular fields. Posterior border furrow very broad (sag.) in young specimens, gradually narrowing according to growth. Middle body almost perfectly oval, anterior part (median boss) large, gently convex, and separated from oval areas by a shallow semi-circular furrow. Oval areas separated from each other by a narrow but very distinct longitudinal furrow, each oval area with very fine and very closely spaced sculptural lines parallel to lateral and posterior margins.

Thoracic segments with rachial ring 46% as wide as complete segment, 25% as long as wide, gently convex transversely, very slightly convex longitudinally, posterior margin even and unserrated, and with very strong and strongly convex forwards sculptural lines. Ring furrow narrow (sag.), distinctly concave, shallow but sharply defined. Articulating half ring very gently convex longitudinally, and about half as broad (sag.) as rachial ring. Pleura very gently convex, with very strong sculptural lines running outwards and slightly obliquely backwards. Anterior pleural band very gently convex (exsag.), produced into a short, slender spine, posterior pleural band wedge-shaped, very gently concave, giving rise to a shallow, ridge-like pleural furrow. Fulcrum process very low, and fulcrum socket almost vanished. Dorsal furrow shallow but very distinctly defined.

Pygidium 97% as long as wide, widest across transverse mid-line. Rachis half as long as pygidium, strongly convex both transversely and longitudinally, triangular. Articulating half ring very broad (sag.). Articulating ring furrow broad (sag.) but shallow. First rachial ring narrow (sag.) mesially, becoming rapidly wider close to dorsal furrow, posteriorly limited by a very shal-
low ring furrow. Second rachial ring triangular, rather convex, probably produced into a very short postrachial ridge. Pleural field flattened, with very strongly impressed interpleural furrows, posteriorly also with a shallow axial furrow, and with strong sculptural lines running strongly convex forward across each pleural segment. First pair of pleural spines reaching beyond tips of sharp and distinctly smaller second pair.

**Dimensions.**

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**Remarks.** — The Norwegian material agrees very well with that from the type locality. As emphasized by Dean (1959, pp. 222–223, 1963, pp. 250–251), and subsequently by Bruton & Owen (1979, pp. 220–221), the fauna of the uppermost part of the Solvang Formation (= “Upper Chasmops Limestone”) corresponds very well with that of the late Caradoc of Shropshire, England. Although the Norwegian material of *Remopleurella* from this horizon may differ very slightly from the British material of *R. burmeisteri*, the author regards the material as being conspecific with that species. The slight differences, such as length-width proportions of the median area, may be caused by differences in preservation. *Remopleurella impressa* Dean (1974, pp. 77–79, pl. 31, figs. 3–4, 6, 8–11, pl. 33, figs. 10, 14), junior synonym of *Remopleurella sculptilis* (Dean 1974, pp. 74–75, pl. 32, figs. 5, 7, 12, pl. 44, figs. 8, 10–11) from the considerably younger Rawtheyan Kildare Limestone of eastern Ireland is also strikingly similar to the Norwegian material of *R. burmeisteri*. The holotype cranidium of *R. impressa*, which is distorted, has a shorter median area, while the paratype cranidium has equal proportions to Norwegian specimens of the same size. However, the median area of *R. impressa* has slightly convex forwards sculptural lines, as opposed to the concave pattern in the Norwegian material of *R. burmeisteri*. Similarly, the pattern of the sculptural lines on the thoracic segments is different; transverse on the pleurae in *R. burmeisteri*, strongly convex forwards on those of *R. impressa*. The rachis of the pygidium seems to be much narrower in *R. burmeisteri* than in *R. impressa*. Noteworthy in this connection are the cranidia from the Pusgillian Venstøp Formation of Eastern Raudskjær, Oslo–Asker, described and figured by Owen (1981, p. 17, pl. 3, figs. 14–15) as *Amphitryon?* sp. B, which have a sculptural pattern on the median area similar to that of *R. impressa*.

The two hypostomes figured by Apollonov (1974, pl. 21, figs. 2–3) from the Ashgill of Kazakhstan, U.S.S.R., are remarkably similar to those of *R. burmeisteri*. They differ in being narrower over the posterior half. Three pygidia reported by Apollonov 1974 (pp. 19–20, pl. 19, figs. 14–16) were referred to *Amphitryon* sp., but they may also belong to *Remopleurella*. Judging from Apollonov’s illustrations, the pygidia seem to be intermediate between *Remopleurella* and *Amphitryon*, and differ from that of *R. burmeisteri* in having shorter rachis and more convex pleural fields.

**Occurrence.** — Abundant in the uppermost part of the Solvang Formation (= “Upper Chasmops Limestone, 4bδ”) in the western part of the Oslo–Asker district: Ostøya (approx. 2.5 m be-
low top), Terneholmen (approx. 2 m below top), and Eastern Raudskjær (1.7–1.8 m below top). Venstøp Formation: Nakkholmen (0.85–1.02 m above base).

Genus *Amphitryon* Hawle & Corda, 1847

*Type species.* – By original designation *Amphitryon* *Murchisonii* Hawle & Corda, 1847 (subjective synonym of *Caphyra radians* Barrande, 1846, p. 32) from the Králťtv Dvår Formation (Ashgill) of Bohemia, Czechoslovakia.

*Remarks.* – For discussion of relationship, see *Sculptella* n. gen. (p. 265), *Sculptaspis* n. gen. (p. 276) and *Remopleurella* (p. 288).

*Amphitryon* sp.

Pl. 15, fig. 1

☐ 1979 *Remopleurella* sp. nov. – Owen, p. 251 (Listed). ☐ 1979 *Remopleurella* sp. nov. B – Bruton & Owen, p. 218 (Listed).


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*Remarks.* – This cranidium is included in the genus *Amphitryon* on the basis of the following characters; the almost flattened and smooth median area, the very narrow base of glabellar tongue, only a very slight postero-lateral bend of palpebral furrow, the short occipital furrow, and the depressed occipital ring. The cranidium almost certainly represents a new species, but more complete material is needed to formally name it. *A.* sp. differs from the type species in having a shorter median area, much broader palpebral rims, and shorter occipital furrow.

Possibly *A.* sp. is more closely related to *A. radians angustatus* (Törnquist, 1884, pp. 36–37, pl. 1, figs. 35–38) from the lower Ashgill Tretaspis Shale of Jämtland in Sweden than to the nominate subspecies. The broad palpebral rims indicates this. Besides having even broader palpebral rims than *A. radians angustatus*, it differs from this in having a shorter median area and a narrower base of the glabellar tongue.

*Description.* – Cranidium suboval in outline, distinctly wider than long. Median area oval, almost two-thirds as long as wide, widest across transverse mid-line, almost flattened, and with the test completely smooth except for the three pairs of conspicuous lateral glabellar furrows. S1 strongly impressed, rather convex forwards, about 30% as long as width of median area. S2 much less strongly impressed, very slightly convex forwards, 20% as long as width of median area. S3 very shallow, strongly oblique, only 17% as long as S1. Glabellar tongue is largely broken off in the specimen, but the width between anterior ends of palpebral rims is 20% the width of median area. Palpebral furrow narrow and shallow, with postero-lateral bend extremely faintly impressed. Palpebral rim rather broad, only slightly broader posteriorly than anteriorly, very slightly convex in cross-section, sloping gently downwards inwards, and very gently arched down in lateral view. Occipital furrow shallow and almost straight, 30% as wide as median area. Occipital ring depressed, strongly convex transversely, very slightly convex longitudinally, and with even, unserrated posterior margin. Occipital tubercle large and prominent, located close to occipital furrow.

Genus *Robergia* Wiman, 1905


*Robergia sparsa* n. sp.

Pl. 15, figs. 2–7

*Name.* – From Latin *parsus*, few, rare, scattered, referring to the rarity of the species.

Type stratum and type locality. Ogygiocaris Shale, 4aa. Road section between Nydal and Furnes Church, Nes-Hamar district.

Other material. – Ten rather fragmentary cranidia, some small fragments of thoracic segments, and five pygidia.

Diagnosis. – Median area three-fifths as long as wide, very finely sculptured, with a median furrow anteriorly. Glabellar tongue short, three-fifths as wide as median area. Occipital furrow less than half as wide as median area. Pygidium subquadrate, four-fifths as long as wide, rachis with six rings, first pair of pleural spines located far behind rachial end.

Description. – Cranidium 95 % as long as wide. Median area 61 % as long as wide, very slightly convex, with a short and shallow longitudinal furrow on the anterior part, and with extremely fine and very closely spaced sculptural lines running convex forwards on median anterior part, longitudinally on mesial and lateral parts, but transversely on posterior part. Three pairs of narrow but very strongly impressed lateral glabellar furrows. S1 moderately convex forwards, with a short forwardly directed bend at the inner end, 24 % as long as width of median area, and with the distance between the two furrows 72 % the length of each furrow. S2 open inverted V-shaped, with the inner part straight, the lateral part somewhat convex forwards and more strongly impressed, 32 % as long as width of median area, and with a rather short distance between the two furrows. S3 very narrow but sharply defined, straight, directed abaxially obliquely forwards, 15 % as long as width of median area. Glabellar tongue bulbous, overhanging the preglabellar field, with strongly convex lateral margins, 60 % as wide as median area, 55 % as long as wide, and with very fine and closely spaced, forwardly convex sculptural lines. Preglabellar furrow shallow. Preglabellar field narrow (sag.) and list-like, slightly broader laterally than at axial line. Dorsal furrow narrow and shallow. Palpebral furrow narrow and shallow but sharply defined. Anterior rim very slightly convex in cross-section, narrow and passing gradually into preglabellar field. Palpebral rim of moderate and even width, with a narrow but sharply defined median furrow producing an open V-shape in cross-section, and with sculptural lines parallel to margins. Occipital furrow narrow and shallow, straight at middle part but concave forwards laterally, its width being 44 % that of median area. Occipital ring moderately convex transversely, flattened longitudinally, 33 % as long as wide. Occipital tubercle small. Posterior or fixigenae not properly preserved in present material.

Librigena and hypostome unknown.

Thoracic segment with rachial ring 66 % as wide as complete segment, 21 % as long as wide, and with thin but closely spaced, slightly concave forwards sculptural lines. Ring furrow convex (tr.), relatively broad (sag.) but shallow. Articulating half ring furrow convex (sag.), half as broad (sag.) as rachial ring at axial line, and with faint, sculptural lines which are convex forwards. Pleural field flattened, subrectangular, only slightly wider than long. Dorsal furrow shallow, not well defined.

Pygidium flattened, 81 % as long as wide, somewhat wider posteriorly than anteriorly. Rachis prominent, strongly convex (tr.), 42 % as wide as pygidium, gradually tapering rearwards to reach 67 % the length of pygidium, produced rearwards into a postrachial ridge. Rachis composed of six rachial rings, the first one with a distinct incision posteriorly. Pleural field rather flat; with interpleural ‘furrows’ developed as very low ridges, and with very fine sculptural lines running transversely posteriorly, anteriorly gradually becoming directed abaxially obliquely forward. First pair of pleural spines prominent, located very close to postero-lateral corners, second pair somewhat smaller and blunter, located about half-way between lateral margin and axial line, third pair very blunt, located close to axial line. Dorsal furrow strongly impressed anteriorly, rapidly dying out rearwards. Doublure broad, reaching a line drawn from antero-lateral corner of pygidium to rachial end.

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Remarks. – The longitudinal furrow on the anterior part of the median area has earlier been reported in *R. yukonensis* Lenz & Churkin (1966, pp. 41–44, pl. 4, pl. 5, figs. 1–5) from the Upper Ordovician of Yukon Territory, U.S.A. This species is quite unlike *R. sparsa*, and probably represents a separate genus as intimated by Lenz & Churkin, possibly together with *R. deckeri* Cooper, 1953 and the specimen *R. sp.* of Chugaeva 1964 (p. 29, pl. l, fig. 5) from the uppermost Middle Ordovician of north-eastern U.S.S.R. Material of the apparently related *R. deckeri* from the Middle Ordovician Copenhagen Formation of Nevada, U.S.A., was described and figured by Ross & Shaw (1972, p. 16, pl. l, figs. 16–21). The longitudinal furrow in the cranium of *R. yukonensis* was then thought to be accentuated by crushing in the specimen, and not considered as an original feature, thus was not reported in the described material. As far as can be judged from the figured material, a shallow furrow is present as in *R. sparsa*, although this species is not closely related. The author has had the opportunity of studying the beautifully preserved Swedish material from the Llandeilo *Ogygiocaris* Shale of Jåmtland, recorded by Thorslund (1937, p. 11) as *Robergia* n. sp. The cranium of this underscribed species has a short but very distinct furrow between *S*3 as in *R. sparsa*, and the cranidia of the two species can hardly be separated. However, the pygidium is completely different. It is much narrower in *R. n. sp.* than in *R. sparsa*, and has the very small first pair of pleural spines located opposite rachial end, and the large pointed second pair located at posterolateral corners. The pygidium of the Swedish species seems to occupy an intermediate position between that of *R. sparsa* and that of the North American species *R. schlotheimi* (Billings, 1865). The cranium of *R. schlotheimi* is remarkably similar to those of *R. sparsa* and *R. n. sp.* when not considering the longitudinal furrow on median area of the two latter.


**Robergia microphthalmalma** (Linarsson, 1875)

Pl. 15, figs. 8–14

□ 1875 *Remopleurides microphthalmalma* n. sp. – Linarsson, pp. 494–495, pl. 22, fig. 3 (Descr. and fig. of cranium). □ 1898 *Dicellocephalus microphthalmalma* (Linn.) – Holm, pp. 464–467, pl. 1, figs. 1–2 (Descr. and figs. of librigenae and pygidium). □ 1905 *Robergia microphthalmalma* Lns. – Wiman, pp. 77–78, pl. 5, figs. 1–4 (Remarks and figs. of cranidia and pygidium).

□ 1907 *Robergia microphthalmalma* Lnsrs. sp. – Moberg, pp. 83–87, pl. 1, fig. 4 (Remarks and fig. of cranium). □ 1913 *Robergia microphthalmalma* Lnsrs. sp. – Hadding, p. 78, pl. 8, figs. 15–18 (Remarks and figs. of cranidia and pygidia).


**Holotype (by monotypy).** – A broken and incomplete cranium figured by Linarsson 1875, pl. 22, fig. 3, SGU unnumbered, from the Ogygiocaris Shale at Önsvedsbäcken, Jämtland in Sweden.

**Norwegian material.** – Twenty more or less fragmentary cranidia, one poorly preserved librigena, several fragments of thoracic segments, and twelve more or less fragmentary pygidia.

**Dimensions.** –

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Middle Ordovician trilobites

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Remarks. – The present material agrees well with the Swedish material of *R. microphthalmalma*. It seems to differ only very slightly in having a somewhat narrower pygidium with smaller pleural spines. In Jämtland, Sweden, *R. microphthalmalma* is found in the Ogygiocaris Shale, which includes the graptolite zones of *Climacrograptus pusillus* and *Nemagraptus gracilis*. The higher of these corresponds quite well with the occurrence of the Norwegian material.

*R. microphthalmalma* may be related to *R. sparsa* n. sp. (pp. 292–294, pl. 15, figs. 2–7), a species which appears earlier in the succession in the same area (probably zone of *Didymograptus murchisoni*). The cranidium of *R. sparsa* is separated by its longitudinal furrow at anterior mesial part of median area. The most conspicuous difference is found in the pygidia. In *R. sparsa* it is widest posteriorly, with the first pair of pleural spines located far behind rachial end, whereas in *R. microphthalmalma* it is widest anteriorly, with the first pair of pleural spines located opposite rachial end.

The most similar North American species is *R. major* Raymond (1920, pp. 281–282, 1925, pp. 60–61, pl. 3, figs. 6–10) from approximately Llandeilo deposits of Virginia, U.S.A. The cranidia can hardly be separated, but the pygidium of *R. major* is narrower and more quadrate-shaped than that of *R. microphthalmalma*.

Occurrence. – Hovindsholm Shale. Ringsaker: Road section just south of the farm Heramb, and river bank at eastern side of Brumundelva near Holmen (28–48 m from base of formation).

Acknowledgements. – I am deeply indebted to Professor Gunnar Henningsmoen for providing working facilities at the Palaeontological Museum, access to collections and to his own library, and for inspired supervision. He also critically read the manuscript. Dr. J. Fredrik Bockelie provided some of the new material and assisted with the illustrations. Additional help with photography and drawings was provided by Mr. Per Aas, Professor Kent Larsson and the late Professor Per Thorslund. Dr. Ralph Männil gave valuable information on specimens from Estonia.

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Fig. 16. Dorsal view of almost complete paratype thoracic segment. PMO 88125. Ampyx Limestone, 4aβ. Huk, Bygdøy, Oslo. Coll. W. C. Brøgger, 1882. × 5.

Fig. 17. Dorsal view of almost complete paratype pygidium. PMO 3724. Horizon, locality and collection as fig. 16. × 14.

Fig. 18. Dorsal view of paratype young meraspid pygidium, corresponding well with transistory pygidia of degree 0 of Whittington 1959. PMO 88126. Horizon, locality and collection as fig. 16. × 30.
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Figs. 1–8. **Sculptella scriptoides** n. gen., n. sp. ................................................................. p. 271
Fig. 5. Right dorso-lateral view of paratype librigena. Polyester cast made from two pieces of the same librigena, one of them being an external counterpiece. PMO 2943 and 95469. Ampyx Limestone, 4αβ. Håkavik, Asker. Coll. O. Holtedahl, unknown. × 4.
Fig. 8. Dorsal view of incomplete paratype thoracic segment. PMO 4028. Ampyx Limestone, 4αβ. Between Arnestadstrand and Holmen, Asker. Coll. J. Kier, 1898. × 5.

Figs. 9–17. **Sculptella angustilingua** n. gen., n. sp. ................................................................. p. 272
Fig. 9. Dorsal view of incomplete paratype cranidium. PMO 74679. Ampyx Limestone and Shale, 4αβ, fragment beds in the lowermost part. Gullerud, western side of Røysetangen, Ringerike. Coll. W. C. Brøgger, 1881. × 7.
Fig. 10. Dorsal view of large, fragmentary paratype cranidium. Note very thin test. PMO 20314. Horizon, locality and collection as fig. 9. × 7.
Fig. 14. Anterior view of detail of glabellar tongue of paratype cranidium. PMO 74689. Horizon, locality and collection as fig. 9. × 36.
Fig. 15. Right dorso-lateral view of small paratype librigena. PMO 74680. Ampyx Limestone and Shale, 4αβ, fragment beds in the lowermost part. Beach profile below Gomnes, western side of Røysetangen, Ringerike. Coll. J. Kier, 1914. × 7 1/2.
Fig. 16. Left dorso-lateral view of paratype librigena. PMO 74681. Horizon, locality and collection as fig. 15. × 7 1/2.
Fig. 17. Left dorso-lateral view of paratype librigena. Note large genal notch. PMO 4234. Horizon, locality and collection as fig. 9. × 7.
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Figs. 1–4. *Sculptella angustilingua* n. gen., n. sp. .......................................................... p. 272
Fig. 1. Silicone rubber cast. Ventral view of paratype hypostome, partially exfoliated. PMO 4319. Ampyx Limestone and Shale, 4aβ, fragment beds in the lowermost part. Beach profile below Gomnes, western side of Røysetangen, Ringerike. Coll. J. Kjær, 1913. × 121/2.

Fig. 2. Anterior view of small paratype cranidium. PMO 74690. Ampyx Limestone and Shale, 4aβ, 3–4 m above base. Road section between Gullerud and Kullerud, western side of Røysetangen, Ringerike. Coll. L. Størmer and G. Henningsmoen, 1941. × 15.

Fig. 3. Dorsal view of fragmentary paratype thoracic segment, probably representing the seventh segment. PMO 0551a. Horizon as fig. 1. Gullerud, western side of Røysetangen, Ringerike. Coll. W. C. Brøgger, 1871–1881. × 12.

Fig. 4. Dorsal view of fragmentary paratype pygidium. PMO 0551b. Horizon, locality and collection as fig. 3. × 18.

Figs. 5–12. *Sculptaspis cordata* n. gen., n. sp. .......................................................... p. 278

Fig. 9. Latex cast. Left lateral view of fragmentary paratype librigena showing keel-like doublure along the median suture. PMO 100507. Horizon, locality and collection as figs. 5–8. × 7 1/2.


Figs. 13–17. *Sculptaspis insculpta* n. gen., n. sp. .......................................................... p. 281

Fig. 17. Dorsal view of distorted, late meraspid paratype cranidium. PMO 74699. Ogygiocaris Shale, 4aα5. Elnestangen, Asker. Coll. G. Henningsmoen, 1959. × 15.
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Figs. 1–7. *Sculptaspis erratica* n. gen., n. sp. ............................................................ p. 279
Figs. 1–4. Dorsal, anterior and right lateral views of holotype cranidium, and detail of glabellar tongue showing preglabellar field. PMO 74703. Ogygiocaris Shale, 4aα. Road section between Nydal and Furnes Church, Nes-Hamar. Coll. F. Nikolaisen, 1969. Fig. 1 x 7 1/2, figs. 2–3 x 7, fig. 4 x 18.
Fig. 5. Silicone rubber cast. Right dorso-antero-lateral view of fragmentary paratype cephalon. PMO 60393. Ogygiocaris Shale, 4aα. Road section at Muggerudkleiva, Heistad, Eiker-Sandsvær. Coll. L. Størmer, 1925–1927. x 6 1/2.
Fig. 6. Dorsal view of paratype cranidium. PMO 67194. Ogygiocaris Shale, 4aα. Sterudstranda, Nes. Coll. S. Skjeseth, 1950. x 7 1/2.
Fig. 7. Dorsal view of early holaspid paratype cranidium. PMO 74702. Horizon and locality as figs. 1–4. Coll. S. Skjeseth, 1950. x 12.

Figs. 8–10. *Sculptaspis pannucea* n. gen., n. sp. ............................................................ p. 282

Figs. 11–13. *Sculptaspis sexlineata* (Angelín, 1851) ............................................................ p. 285
Dorsal, anterior and right lateral views of large, distorted cranidium. PMO 20360. Lower Chasmops Shale, 4ba. Oscarshall, Bygdøy, Oslo. Coll. unknown, old collection. x 3 1/2.

Figs. 14–18. *Sculptaspis impolita* n. gen., n. sp. ............................................................ p. 283
Figs. 14–17. Dorsal, anterior and left lateral views of holotype cranidium, and detail of glabellar tongue showing preglabellar field. PMO S. 1944. Lower Chasmops Shale, 4ba. Eastern end of second railroad tunnel, west of Billingstad Station, Asker. Coll. N. Spjeldnæs, 1952. Figs. 14–16 x 8, fig. 17 x 36.
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Figs. 4–13. *Sculptella*(?) *nonscripta* n. gen., n. sp. ........................................... p. 274
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Fig. 5. Dorsal view of paratype cranidium. PMO 74667. Ampyx Limestone, 4αβ. Road section at Snarøyveien just north-east of Fornebu Airport, Snarøya, Bærum, Oslo–Asker. Coll. D. L. Bruton, 1967. × 7 1/2.
Figs. 6–9. Detail of glabellar tongue showing preglabellar field, and right lateral, anterior and dorsal views of holotype cranidium. PMO 74668. Horizon and locality as fig. 5. Coll. F. Nikolaisen, 1967. Fig. 6 × 15, figs. 7–9 × 5.


Figs. 16–17. *Sculptaspis* sp. ................................................................. p. 286
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Fig. 9. Dorsal view of young holaspis cranidium. PMO 74775. Horizon, locality and collection as figs. 1–3. × 15.
Fig. 10. Dorsal view of partially exfoliated cranidium. Note the very thin test. PMO 20419. Horizon, locality and collection as fig. 8. × 7.
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Fig. 17. Dorsal view of incomplete left librigena. PMO 74777. Horizon and locality as fig. 7. Coll. F. Nikolaisen, 1964. × 4.
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