THE MIDDLE ORDOVICIAN OF THE OSLO REGION, NORWAY
23. THE TRILOBITE FAMILY PROETIDAE

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Proetid trilobites from the Middle Ordovician of Norway are described and figured for the first time. From the fragmentary but well preserved material it has been possible to distinguish four species af *Decoroproteus* Přibyl; *D. furubergensis* sp. nov., *D. gyratus* sp. nov., *D. solenotus* sp. nov., and *D.* sp. A. These species can be compared with ones occurring in the Middle Ordovician in the Girvan area of the British Isles and in North America. A new genus, *Analocaspis* gen. nov. (type species *Analocaspis ursina* sp. nov.) is erected for a proetid-like species from the Lower Chasmops Shale. It has not been found outside the Oslo Region.

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Introduction

Proetid trilobites only occur at horizons within the Chasmops Series of the Middle Ordovician in the Oslo Region (see Table 1), the species *Decoroproetus furubergensis* sp. nov. being the most widespread, occurring in the Upper Chasmops Shale and its northern equivalent, the Cyclocrinus Shale. This species is present in beds of probable Upper Chasmops Limestone age. The other *Decoroproetus* species are less common, and have not been found at so many localities. The supposed proetid *Analocaspis ursina* gen. et sp. nov. is known only from the type locality.

The term 'Middle Ordovician' is accepted herein in the sense of Størmer, i. e. from the base of the Didymograptus bifidus zone ($4a\alpha_1$) to the top of the Upper Chasmops Limestone ($4b\delta_2$).

Terminology

Most of the terms used are those defined by Harrington et al. in Moore (1959, pp. O 117 – O 126). The following additional terminology is useful when describing proetids.

Eye socle, defined by Shaw & Ormiston (1964, p. 1002), is used for that curb-like ridge which supports the visual surface of the eye.

	STANDARD BRITISH GRAPTOLITE SUCCESSION	SHELLY SUCCESSION OF SHROPSHIRE AND N. ENGLAND	UPPER PART OF MIDDLE ORDOVICIAN SUCCESSION OF OSLO DISTRICT	PROETID TRILOBITES WITH KNOWN STRATIGRAPHIC DISTRIBUTION	DISTRICTS OF THE OSLO REGION: OSLO-ASKER	RINGERIKE	HADELAND	NESHAMAR
CARADOC	Dicranograptus clingani	ONNIAN / ACTONIAN	4bδ Upper Chasmops Limestone	Decoroproetus solenotus	+	+	•	•
				Decoroproetus sp. A.	•	+	•	•
				Decoroproetus furubergensis	•	•	+	•
	Climacograptus wilsoni	MARSHBROOKIAN; LONGVILLIAN UPPER	4bγ Upper Chasmops Shale	Decoroproetus furubergensis	•	+	+	+
		LONGVILLIAN UPPER / LOWER	4bβ Lower Chasmops Limestone		•	•	•	•
	Climacograptus peltifer	SOUDLEYAN / HARNAGIAN	4bα Lower Chasmops Shale	Analocaspis ursina	+	•	•	•
				Decoroproetus gyratus	+	•	•	•

Table I Known distribution of Proetid trilobites in the Middle Ordovician of the Oslo District. Correlation of Shelly succession after Dean 1960.

Greek lettering, introduced by R. & E. Richter (1949, p. 69) to define points on the course of the facial suture is found useful, and the terms beta, gamma, epsilon and zeta are employed herein (see Fig. 1).

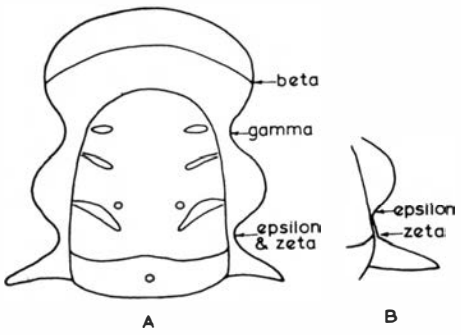

Fig. 1. Generalized proetid cranidium showing the different points on the facial suture indicated by the Greek litteration.
A. Epsilon and zeta as one angle
B. Epsilon and zeta as separate angles.

Orientation and measurement of specimens

To facilitate comparison, measurements are made on cranidia and pygidia wherever possible, and are tabulated under each species. All measurements are in millimetres. The measurements taken are shown in Fig. 2. In the taking of the measurements, and in the photographs, the cranidium is orientated so that the palpebral lobe is horizontal, and the pygidium so that the axial furrow is horizontal.

Systematic descriptions

Family PROETIDAE Salter, 1864, Subfamily PROETIDELLINAE Hupé, 1953.

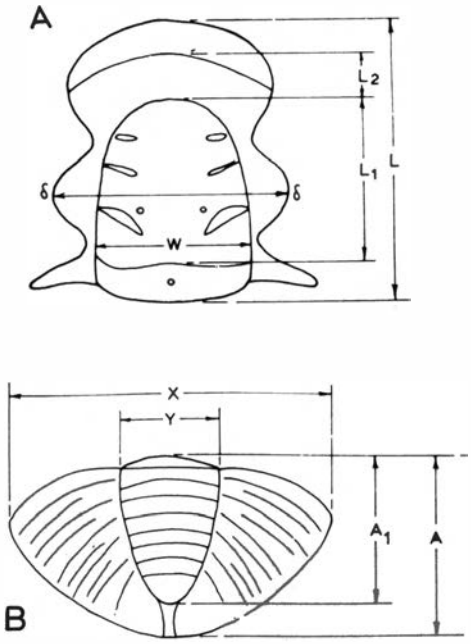

Fig. 2. Orientations and measurements used on the proetid cranidium and pygidium. The cranidium is orientated so that the palpebral lobe is horizontal, and the pygidium so that the axial furrow is horizontal. These orientations are also used in the photographs (Figs. 5–8).
Cranidial measurements: (Fig. 2, A).
L = total length of cranidium (sag.).
L_1 = sagittal length of the glabella.
L_2 = sagittal length of the preglabellar field (except in *Analocaspis ursina*, where L_2 is the sagittal length of the preglabellar field plus the anterior border).
W = width (trans.) of the glabella at its widest point.
δ–δ = palpebral width (trans.) of the cranidium.
Pygidial measurements: (Fig. 2, B).
A = sagittal length of pygidium.
A_1 = sagittal length of pygidial axis.
X = greatest width (trans.) of pygidium.
Y = anterior width (trans.) of pygidial axis.

Genus *Decoroproetus* Přibyl, 1946

(Synonyms *Proetidella* Bancroft, 1949, *Ogmocnemis* Kielan, 1960, *Warburgaspis*, Přibyl, 1946). Type species: *Proetus decorus* Barrande, 1846.

Decoroproetus Furubergensis sp. nov.

Fig. 5, A–K, Fig. 6, E, G–M, Fig. 7, L.

Derivation of the name. – From the type locality, Furuberget, Nes-Hamar district.

Holotype. – A cranidium (PMO 8700), Fig. 5, B, E, Fig. 7, L.
Material. – Besides the type, 12 cranidia 7 free cheeks and 9 pygidia.

Type stratum and type locality. – Cyclocrinus Shale (4bα), Furuberget, Nes-Hamar-district, Oslo Region.

Occurrence. – Upper Chasmops Shale (4bγ) and probably Upper Chasmops Limestone (4bδ); Ringerike, Hadeland and Nes-Hamar districts, Oslo Region, Norway.

Diagnosis. – Glabella with three pairs of distinct lateral glabellar furrows interrupting the glabellar sculpture; a well developed eye socle, without a deep furrow at its base; pygidial axis with six rings; no postaxial ridge; sculpture of fine, raised, discontinuous ridges on parts of the cranidium, free cheeks, and on the axial region of the pygidium.

Description. – The cranidium has the sagittal length slightly greater than the palpebral width. The glabella is of approximately equal length and breadth, narrowing forwards weakly with the frontal lobe bluntly rounded. The glabella is defined by distinct conjoined axial and preglabellar furrows, and is weakly constricted at 2p. The glabella is moderately convex in both lateral and longitudinal profiles, and the frontal lobe curves down fairly rapidly to the preglabellar furrow in lateral profile (see Fig. 3, A, C). Three pairs of glabellar furrows are present, represented by smooth areas in the glabellar sculpture. 1p is situated opposite the anterior end of the palpebral lobe, directed inwards and backwards at about 45° to an exsagittal line. The furrow widens at mid-length, but narrows to a point distally. It does not reach the occipital furrow, and extends about half way towards the sagittal line. Associated with 1p is a small auxiliary impression. 2p is situated opposite gamma, and is directed backwards at about 30° to an exsagittal line, extending a little further inwards than 1p. 3p is situated near the anterolateral corners of the glabella, represented by a small ovate area, isolated from the axial furrow and no larger than the auxiliary impression (see Fig. 7, L).

The occipital furrow is rather deep, shallowing at the lateral ends, with a steep anterior slope and a shallow posterior slope. It is arched forwards weakly sagittally, and at either end. The occipital ring is fairly wide (sag.), about one quarter of the sagittal length of the glabella. It narrows somewhat

laterally, where the posterior margin bends forwards quite strongly. In lateral profile the occipital ring is moderatly convex, and in longitudinal profile it bends down steeply at either end, with the posterior edge bending down more steeply than the anterior edge. A small median occipital tubercle is present.

The preglabellar field is rather long (sag.), about one third the sagittal length of the glabella. In lateral profile it is convex immediately in front of the preglabellar furrow, and then slopes down in a weakly concave curve to the anterior border furrow. The latter is poorly defined, indicated merely by the change in slope between the preglabellar field and the anterior border, which is weakly convex and upturned.

The anterior branches of the facial sutures are moderatly divergent, with beta a wide, rounded angle. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. The posterior branches of the facial sutures have epsilon and zeta as independent angles, this stretch of the suture running more or less parallel with the axial furrow. From zeta the posterior branches diverge rapidly outwards to cut the posterior margin about half way between the lateral end of the occipital ring and the lateral margin.

The palpebral lobe is rather large, about half the sagittal length of the glabella. It is backwardly placed and is semi-elliptical in outline. In longitudinal profile it rises up steeply from the axial furrow, and is flattened distally. It is not elevated as high as the sagittal region of the glabella (see Fig. 3, C). The eye is prominent, reniform, and mounted on a distinct eye socle. The lower margin of the eye socle is not demarcated by a distinct furrow, but by an abrupt change in slope. The lower margin of the eye socle diverges from the upper margin at both anterior and posterior ends.

The field of the free cheek slopes down fairly steeply from the eye region, the inner part being weakly convex. The lateral border furrow is broad and shallow, with the lateral border slightly upturned and weakly convex. The posterior border furrow is narrower and more steep sided than the lateral, with the posterior border quite strongly upturned. The genal spine is fairly long and rather narrow. Fusing near the base of the genal spine, the lateral and posterior border furrows continue on to it as the median furrow, which quickly shallows posteriorly and is hardly perceptible distally.

The cephalon has a sculpture of short, fine, discontinuous ridges, which form a 'broken thumbprint' pattern on the glabella. The ridges are arched forwards on the occipital ring. They are also present on the posterior part of the preglabellar field, and on the inner part of the anterior border of the holotype. On smaller specimens the latter area is smooth. While discontinuous ridges are found on the inner part of the free cheek, the outer part and the lateral border region are smooth. On the palpebral lobe the discontinuous ridges run forwards and outwards. On the anterior and lateral borders, and on the inner of the genal spine there are two or three strong, subparallel, raised striae.

The pygidium is of subparabolic outline, without a border, and about twice as wide as long on larger specimens, but proportionately longer in smaller specimens (cf. Fig. 6, G and Fig. 6, J) Anteriorly the axis occupies about one third of the total pygidial width, tapering gradually backwards to the bluntly rounded posterior end, not reaching the posterior margin. There is no postaxial ridge. The axis consists of six rings and a short end piece. In lateral view the axis slopes gently backwards, sloping down steeply at the posterior end where it forms a continuous concave curve with the postaxial area (see Fig. 4, A and Fig. 5, G). Each axial ring is weakly convex in lateral profile, with the first ring elevated considerably above the remainder. In longitudinal profile the axis is strongly arched (see Fig. 4, C and Fig. 5, K). The pleural areas have four or five pairs of ribs, which curve gently backwards. Each rib consists of an anterior and posterior pleural band of approximately equal width, and widens distally. The pleural furrow is strong, deepening distally with a steep anterior slope and a shallower posterior slope. The interpleural furrow is rather weak, evident along its entire length and deepening distally. The pleural and interpleural furrows turn backwards quite sharply distally, and the first three or four pairs reach the pygidial margin.

The pygidial axis has a sculpture of forwardly arched, discontinuous ridges. Sometimes these occur on the most anterior pleural band (e. g. Fig. 6, J). The pleural areas are otherwise almost devoid of sculpture, apart from occasional short striae. At the margin there are two or three fine, continuous ridges, which run subparallel to it.

Dimensions (in millimetres). –

Cranidia Specimen no.	L	L_1	L_2	W	δ–δ
Holotype PMO 8700	9.9	5.4	2.5	5.6	?8.0
PMO 68283		1.9	?0.5	2.0	2.9
PMO 68504		3.2	0.9	3.1	4.6
PMO 70442	?3.1	1.8	0.5	2.0	?3.0
PMO 70460		2.7		2.7	4.0
PMO 20649	4.1	2.3	0.7	2.4	3.5
PMO 8816	2.8	1.6	0.5	1.6	?2.2
PMO 8817	3.6	2.1	0.4	2.1	3.0
PMO 8818	3.3	1.8	0.6	1.7	?2.7

Pygidia Specimen no.	A	A_1	X	Y
PMO 8692	3.5	2.7	?6.8	2.0
PMO 8694	3.7	2.9	?7.0	2.0
PMO 20654	4.5	3.6	9.0	3.0
PMO 70447	3.0	2.4	5.5	2.0
PMO 68281	2.5	2.1	4.8	1.6

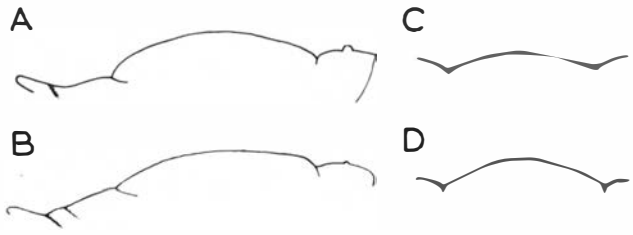

Fig. 3. Lateral and longitudinal profiles of the cranidia of *Decoroproetus furubergensis* sp. nov. (A and C) and *Decoroproetus solenotus* sp. nov. (B and D). The lateral profile is taken along the sagittal line, and the longitudinal profile along δ–δ.

Discussion. – *Decoroproetus furubergensis* is one of the more abundant Middle Ordovician proetids in the Oslo Region. The small differences exhibited between different specimens (cf. Fig. 5, A and E) are taken to be minor intraspecific variations (e.g. glabellar outline, presence or absence of small sculptural elements, degree of convexity of border,etc.). Most of the material comes from the Upper Chasmops Shale or its equivalents, but one cranidium and two free cheeks (Fig. 5, D, H) are from beds of probable Upper Chasmops imestone age.

From the Middle Ordovician outside Norway, *Decoroproetus furubergensis* may be compared with *Decoroproetus jamesoni* (Reed, 1914, Pl. 4, Fig. 8) from the Balclatchie Mudstones of the Girvan area, and with three species of *Proetidella* recently described by Ross (1967, Pl. 2, Figs. 8–18), from the Lexington Limestone of Kentucky. Both these species and *D. furubergensis* share similar glabellar shapes and pygidial proportions, the latter being proportionately shorter than in *Decoroproetus fearnsidesi* (Bancroft) (see Dean, 1963, Pl. 45, Fig. 3). The sculpture of discontinuous ridges of *D. furubergensis* is in contrast to that of *D. fearnsidesi* and many other species of *Decoroproetus,* where the ridges are continuous and cover the entire exoskeleton.

The length-breadth proportions of the pygidium, the number of axial rings (six) and the lack of the postaxial ridge in *D. furubergensis* invite comparison with species of *Cornuproetus (Lepidoproetus)* Erben, 1952, especially *C. (L). regulus* Haas, 1968 from the Lower Devonian of northwestern Turkey (see Haas 1968, Pl. 27, Figs. 15–22 and Text Fig. 9, p. 83). *C. (L). regulus* has an overall similar appearance to *D. furubergensis* but has a number of small differences, notably the wider (sag.) occipital ring, the broader cephalic border, the smaller number of pygidial axial rings (four) and the pygidial pleural ribs bending backwards less strongly. There is a great age difference between the two species, so that the similarity between them may be purely fortuitous. Conversely it may be due to a true phylogenetic

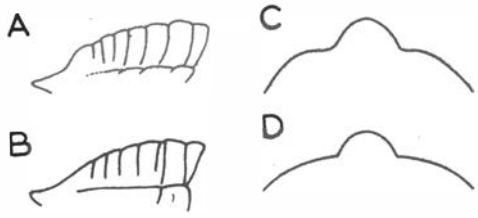

Fig. 4. Lateral and longitudinal profiles of the pygidia of *Decoroproetus furubergensis* sp. nov. (A and C) and *Decoroproetus solenotus* sp. nov. (B and D). The lateral profile is taken along the sagittal line, and the longitudinal profile along a transverse line crossing the first axial ring.

relationship, but evidence from the intervening Upper Ordovician and Silurian is needed before this can be demonstrated with any certainty.

Decoroproetus gyratus sp. nov.

Fig. 6, A, B, D, Fig. 7, M.

Derivation of the name. – From the Latin *gyratus,* turned around, referring to the arrangement of striae on the preglabellar field.

Holotype. – A cranidium (PMO 8702), Fig. 6, A, Fig. 7, M.

Material. – Besides the type, one cranidium (PMO 63296), Fig. 6, B, D.

Type Stratum and type locality. – Lower Chasmops Shale (4bα), shore section below the parking place to Fornebu Airport, Bærum near Oslo.

Occurrence. – Lower Chasmops Shale, the type locality and Bygdøy, Oslo–Asker Region.

Diagnosis. – Glabella with faint, non-impressed lateral furrows. Preglabellar field almost straight in lateral profile. Sculpture of dense, continuous striae, those on the anterior part of the preglabellar field arranged in a transversely elongated concentric pattern.

Description. – The cranidium has the sagittal length considerably greater than the palpebral width. The glabella is a little longer than broad in the holotype, narrowing forwards weakly to the bluntly rounded frontal lobe. The glabella is slightly constricted in front of the palpebral lobe, and in lateral profile slopes down gently from posterior to anterior in a weakly convex curve. In longitudinal profile it is quite strongly convex. Two pairs of lateral glabellar furrows are present on the holotype, interrupting the striated sculpture. (see Fig. 7, M). On the other cranidium (PMO 63296) the furrows are not discernible. 1p is a little anterior to the centre of the palpebral lobe, and is directed backwards at an angle of 45° to an exsagittal line. The furrow widens at mid length and tapers distally to a point, not reaching

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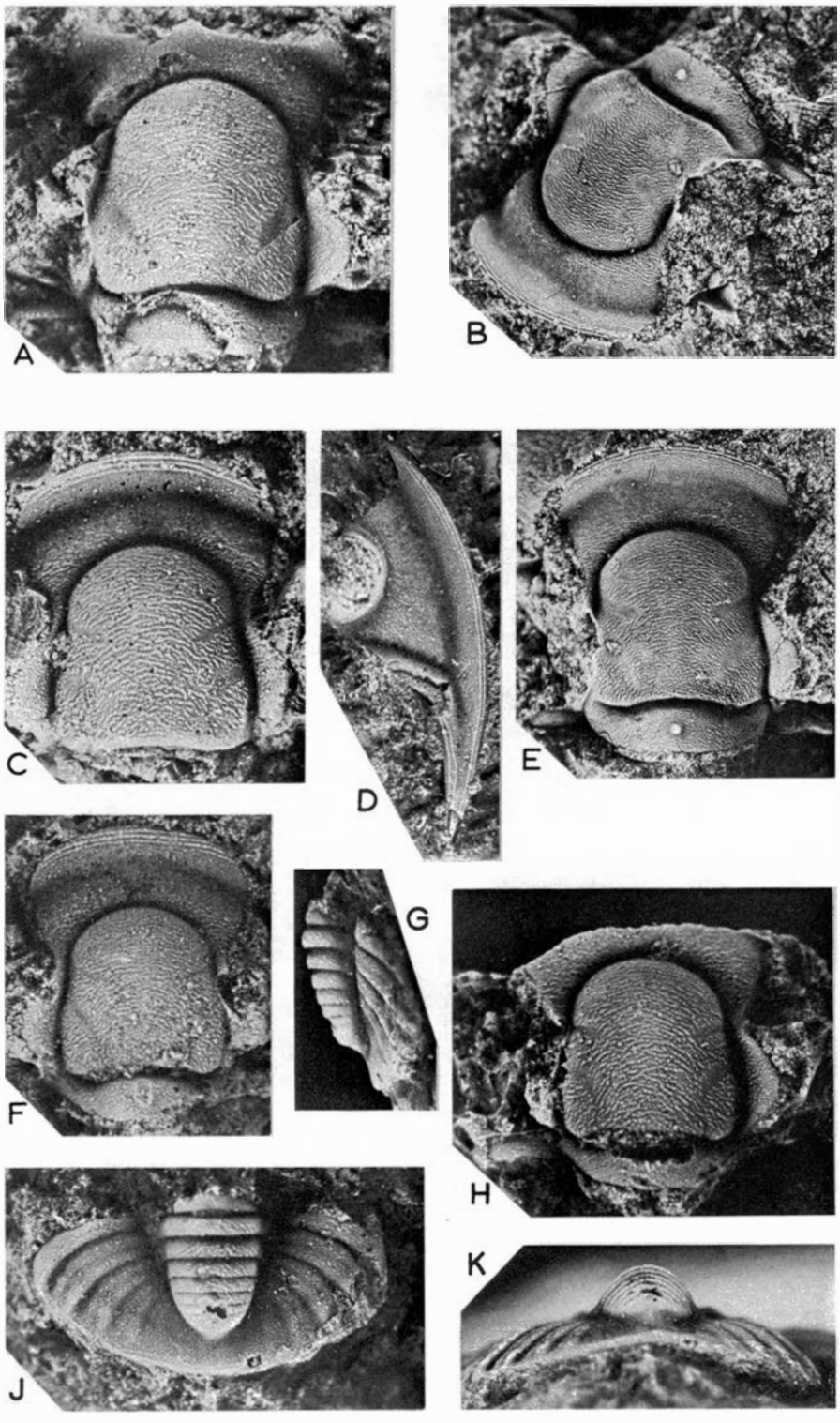
Fig. 5.
Decoroproetus furubergensis sp. nov.
A. C, F. Cranidia, dorsal view. A, × 15 (PMO 68283); C, × 9 (PMO 68504)); F, × 15 (PMO 8816). Probably Upper Chasmops Shale (4bγ), forest track between Nerby and Helgehagen, Lunner, Hadeland. Coll. L. Størmer, 1951.
B, E. Holotype, cranidium, × 4½ (PMO 8700). B, anterior oblique view. Cyclocrinus shale (4bγ), Furuberget, Nes-Hamar. Coll. O. Holtedahl, 1907.
D. Free cheek, dorsal view. × 7 (PMO 70462). Probably Upper Chasmops Limestone (4bδ), at the road, Lyngstad, South Granåsen, Gran, Hadeland. Coll. L. Størmer and G. Henningsmoen, 1941.
H. Cranidium, dorsal view. × 10 (PMO 70460). Other data as for D.
G, J, K. Pygidium, × 7 (PMO 8694). G, lateral view, J, dorsal view, K, posterior view. Upper Chasmops Shale (4bγ), Vestbråten, Røyse, Ringerike. Coll. J. Kiær, 1920.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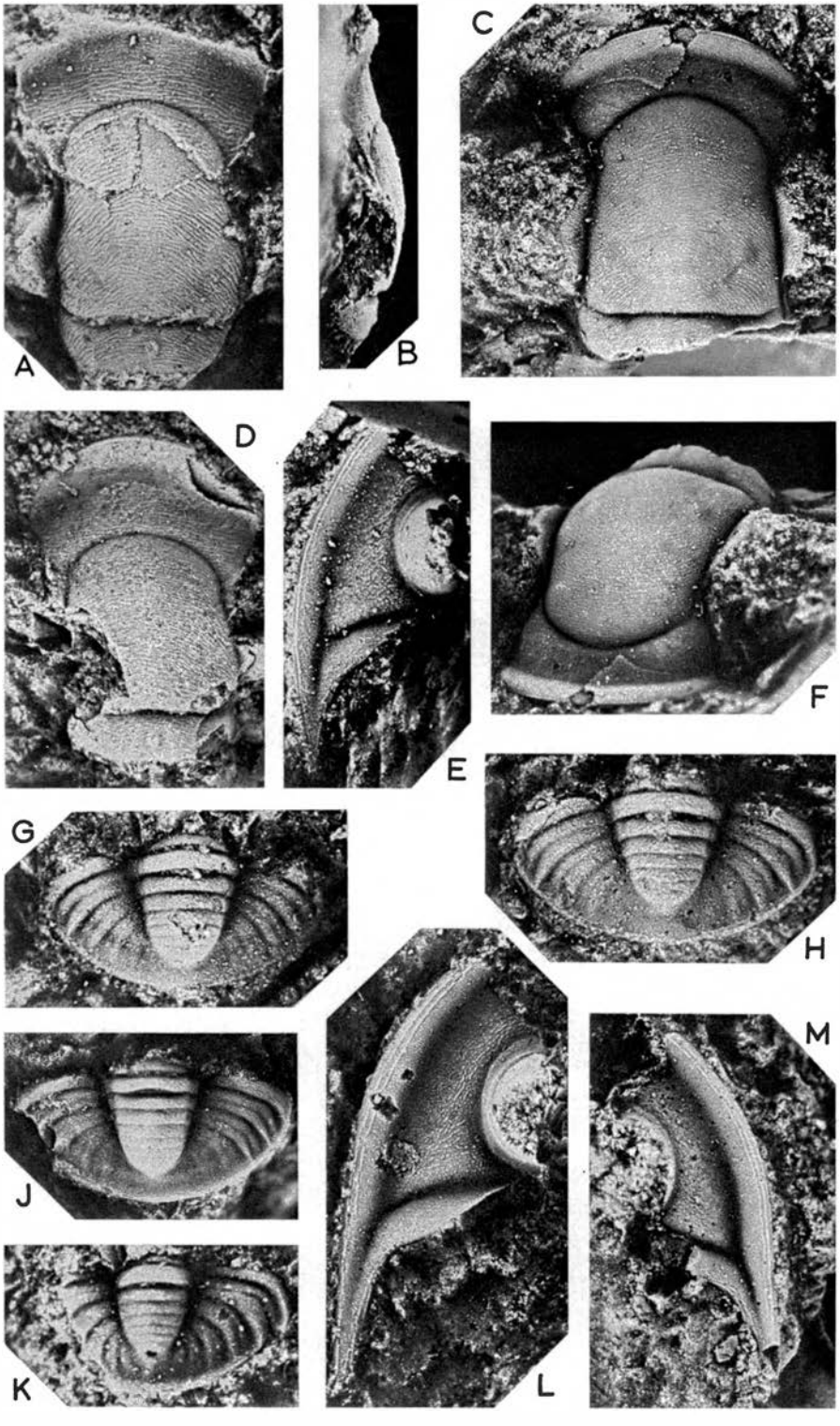
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the occipital furrow and extending about one third of the way inwards towards the sagittal line. 2p is situated opposite the anterior end of the palpebral lobe, and is directed inwards and slightly backwards. It widens a little distally and extends about half way towards the sagittal line.

The occipital furrow is deep, running transversely for most of its length, but bending forwards at either end. The occipital ring is a little shorter (sag.) than the preglabellar field, and it is about the same width as the glabella (trans.). It narrows only very slightly laterally, and lacks the lateral occipital lobes. A small, distinct median tubercle is present. In lateral profile the occipital ring is very weakly convex, rising up gently from the occipital furrow, and in longitudinal profile it bends down steeply at either end.

The preglabellar field is long (sag.), between one quarter and one third the length of the glabella. It slopes down steeply in lateral profile, following the same contour as the frontal lobe of the glabella, and is almost straight (see Fig. 6, B). The anterior border furrow is ill defined, represented by a change in slope between the downsloping preglabellar field and the wide, weakly convex anterior border.

The anterior branches of the facial sutures are strongly divergent, with beta forming a wide curve. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. Gamma is close to the axial furrow, near the constriction of the glabella. The posterior branches of the facial sutures have epsilon and zeta as apparently one angle, close to the lateral end of the occipital ring. From here the posterior branches diverge

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Fig. 6.

Decoroproetus gyratus sp. nov.

A. Holotype, cranidium, × 7 (PMO 8702), dorsal view. Lower Chasmops Shale (4bα); shore section below the parking place to Fornebu Airport ,Bærum, Oslo. Coll. R. M. Owens, 1969.

B, D. Cranidium, × 7 (PMO 63296). B, dorsal view, D, lateral view. Lower Chasmops Shale (4bα), Bygdøy, Oslo.

Decoroproetus sp. A.

C, F. Cranidium, × 12½ (PMO 61018c). C, dorsal view, F, anterior oblique view. Upper Chasmops Limestone (subzone of *Tretaspis kiaeri*, 4bδ_2); western side of Frognøy, Lake Tyrifjorden, Ringerike. Coll. J. Kiær, 1914.

Decoroproetus furubergensis sp. nov.

E, Free cheek, dorsal view, × 8 (PMO 8693). Upper Chasmops Shale (4bγ), Vestbråten, Røyse, Ringerike. Coll. J. Kiær, 1920.

G, H. Pygidia, dorsal view. G, × 8 (PMO 68281); H, × 8 (PMO 70447). Probably Upper Chasmops Shale (4bγ), forest track between Nerby and Helgehagen, Lunner, Hadeland. Coll. L. Størmer, 1951.

J. Pygidium, dorsal view. × 4½ (PMO 20654). Other data as for E.

L, M. Free cheeks, dorsal view. L, × 8½ (PMO 68285); M, × 7 (PMO 68287). Other data as for G.

Decoroproetus solenotus sp. nov.

K. Pygidium, dorsal view. × 21 (PMO 8696). Upper Chasmops Limestone (4bδ_1), 1.7 m. below the top; N. Raudskjær, Asker. Coll. F. Nikolaisen, 1967.

strongly outwards. The palpebral lobe is large, approaching half the length of the glabella, backwardly placed and crescentic in outline. In longitudinal profile it rises up quite steeply from the axial furrow, but soon flattens out. The palpebral lobe is considerably below the height of the sagittal region of the glabella.

The entire cranidium has a sculpture of dense, continuous, raised striae, arranged in a Bertillon pattern. On the preglabellar field they are not so dense, and are arranged in a transversally elongated concentric pattern (see Fig. 6, A).

The remainder of the exoskeleton is unknown.

Dimensions (in millimetres). –

Specimen no.	L	L_1	L_2	W	δ–δ
Holotype PMO 8702	7.1	4.5	1.3	3.7	?5.0
PMO 63296	6.5	3.5	1.3	?3.2	

Discussion. – The two cranidia upon which this species is based are distinctive in the arrangement of the striae on the anterior part of the preglabellar field. The two specimens differ from one another in the distinctness of the lateral glabellar furrows, and on the holotype they are clearly indicated, while on the other specimen they are hardly discernible.

In its glabellar shape, *D. gyratus* is similar to *'Proetidella* sp. B' of Tripp (1967, Pl. 2, Figs. 15–16) from the Middle Ordovician Upper Stinchar Limestone of the Girvan district. The Girvan specimens are too badly preserved to ascertain whether they are conspecific with the Norwegian species.

Decoroproetus solenotus sp. nov.

Fig. 6, K and Fig. 7, A–K.

Derivation of the name. – From the Greek *solenotos,* channeled, alluding to the shallow depression running parallel to the anterior border.

Holotype. – A cranidium (PMO 70437), Fig. 7, B, C, K.

Material. – Besides the type, 3 cranidia, 3 free cheeks and 2 pygidia.

Type stratum and type locality. – Upper Chasmops Limestone ($4b\delta_1$), 1.7 metres below the top, N. Raudskjær, Asker.

Occurrence. – Upper Chasmops Limestone ($4b\delta_1$); Oslo–Asker and Ringerike districts.

Diagnosis. – Cephalon with a shallow depression running subparallel to the border; preglabellar field almost straight in lateral profile; eye socle well

developed, with a distinct furrow at its lower margin; sculpture of very fine, discontinuous striae and minute granules.

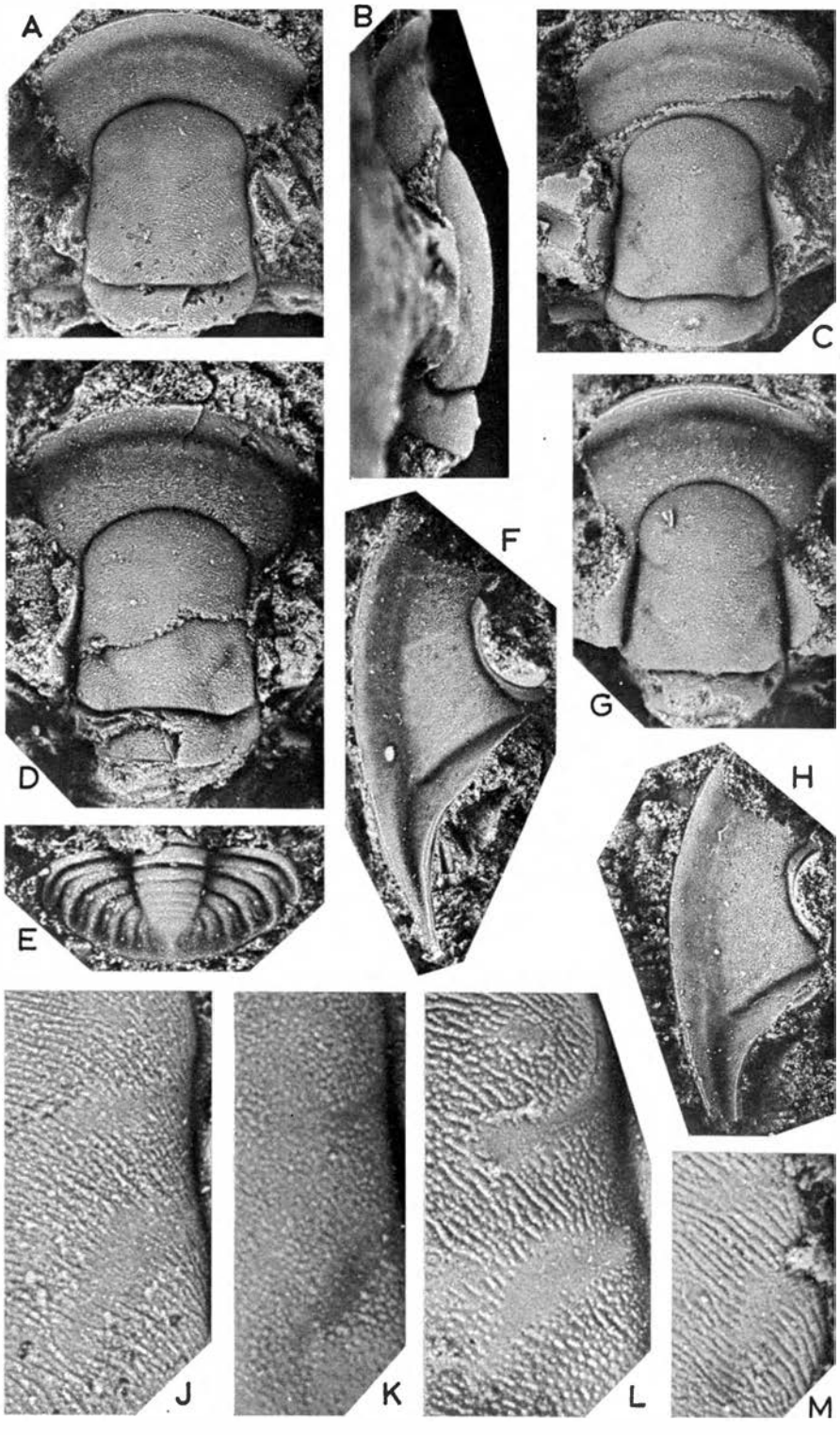
Description. – The cranidium is rather strongly vaulted, with the palpebral width approximately two thirds of the sagittal length. The glabella is defined by shallow, conjoined axial and preglabellar furrows, and is marginally longer than it is wide. From its widest point, at the posterolateral angles, the glabella narrows very gradually forwards and is slightly constricted laterally. In longitudinal profile it is moderately convex (see Fig. 3, D), and in lateral profile it slopes down gently from anterior to posterior, and is weakly convex (see Fig. 3, B and Fig. 7, B). Three pairs of lateral glabellar furrows are present, their positions marked by smooth areas in the glabellar sculpture (see Fig. 7, J, K). 1p and 2p are weakly impressed. 1p is situated more or less opposite the centre of the palpebral lobe, and is directed backwards at about 45° to an exsagittal line. It is widest proximally and narrows rapidly distally, not reaching the occipital furrow and extending about half way towards the sagittal line. Associated with 1p is a small, inconspicuous auxiliary impression. 2p is situated opposite gamma and is narrower and rather shorter than 1p, and is directed inwards and slightly backwards. It is weakly curved with the convex side facing backwards. 3p is inconspicuous, situated a short distance in front of 2p, near the anterolateral corner of the glabella and isolated from the axial furrow, and directed inwards and noticeably forwards.

The occipital furrow is rather deep, arched forwards weakly sagittally, and more strongly laterally. In lateral profile it has a deep anterior slope and a shallow posterior slope. The occipital ring is fairly wide (sag.), narrowing markedly laterally, without lateral lobes. Transversely it is a little wider than the glabella. In lateral profile it is very weakly convex, and slopes up noticeably backwards. In longitudinal profile it plunges down steeply at either end. A small, distinct, median tubercle is present.

The preglabellar field is long (sag.), between half and one third the length of the glabella. It slopes down rather steeply from the preglabellar furrow to the anterior border furrow, and its lateral profile is straight and follows more or less the same line as the glabellar profile (see Fig. 3, B and Fig. 7, B). The anterior border furrow is wide and shallow, with the anterior border weakly convex and slightly upturned. Running a little way inside the anterior border, and parallel with it, is a shallow depression, indicated by a dark band on the preglabellar field (see Fig. 7, A, C, D, and G).

The anterior branches of the facial sutures are strongly divergent, with gamma close to the glabella. Beta is a rather wide, open curve. The posterior branches of the facial sutures have epsilon and zeta as one angle, close to the axial furrow. From this point they diverge strongly outwards to cut the posterior margin close to the base of the genal spine.

The palpebral lobe is backwardly placed, close to the glabella and about half its length, and is subcrescentic in outline. In longitudinal profile it rises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up at angle of 35–40° (see Fig. 3, D), gradually flattening distally. The eye is reniform, rather large and mounted on a distinct eye socle, whose base is demarcated by a distinct furrow, which diverges markedly at either end from the upper margin of the eye socle.

From the eye, the field of the free cheek slopes down quite rapidly to the lateral border furrow. The latter, like the anterior border furrow, is shallow and rather wide. Outside it, lies the rather wide, upturned lateral border. The depression on the preglabellar field continues onto the free cheek, converging with the lateral border near the base of the genal spine (see Fig. 7, F, H). The posterior border furrow has a steep anterior slope and this terminates at the genal spine. The posterior border is rather narrow, and upturned. The genal spine is broad based and tapers rapidly backwards, and bears a wide median groove, produced by the merging of the lateral and posterior border furrows.

The cranidium has a sculpture of very fine, short raised striae, which are arched forwards sagittally on the glabella and occipital ring. They are almost reduced to granules on parts of the glabella and the preglabellar field. The regions of the anterior, lateral and posterior border furrows are almost smooth. On the cephalic border the sculpture is markedly granular. Distinct raised striae occur on the margins of the cephalon, running parallel with it.

The thorax is unknown, but two early holaspid pygidia belonging to this species posses one attached thoracic segment. This lacks the preannulus, and the pleuron has a deep, distinct pleural furrow. The distal end of the pleuron is turned backwards and is bluntly pointed.

Fig. 7.
Decoroproetus solenotus sp. nov.
A. Cranidium, dorsal view, × 10 (RM Ar 37442). ?Upper Chasmops Limestone (4bδ); Ringsåsen, Ringerike. Coll. G. Holm, 1877.
B, C. Holotype, cranidium (PMO 70437). B, lateral view, × 17, C, dorsal view, × 12½. Upper Chasmops Limestone (4 bδ_1), 1.7 m. below the top; N. Raudskjær, Asker. Coll. F. Nikolaisen, 1967.
D. Cranidium, dorsal view, × 7 (PMO 70497). Upper Chasmops Limestone (4bδ_1), close to the top; Kalvøya, N, E. Bærum. Coll. G. Henningsmoen, 1962.
E. Pygidium, dorsal view, × 22 (PMO 8695). Other data as for B.
F. Free cheek, dorsal view, × 7 (PMO 70494). Upper Chasmops Limestone (4bδ_1); 2 m. below the top, Terneholmen, Asker. Coll. F. Nikolaisen, 1967.
G. Cranidium, dorsal view, × 8 (PMO 70495). Other data as for F.
H. Free cheek, dorsal view, × 7½ (PMO 8703). Other data as for F.
H. Free cheek, dorsal view, × 7½ (PMO 8703). Other data as for F.
Detail of the lateral glabellar furrows of *Decoroproetus furubergensis, D. gyratus* and *D. solenotus.*
J, K. *Decoroproetus solenotus.* J, × 35 (RM Ar 37442), K, holotype, × 50 (PMO 70437). For other data see Fig. 7, A and B.
L. *Decoroproetus furubergensis,* holotype, × 18 (PMO 8700). For other data see Fig. 5, B.
M. *Decoroproetus furubergensis,* holotype, × 19 (PMO 8702). For other data see Fig. 6, A.

The early holaspid pygidium is of subparabolic outline, without a border. The axis is about one third of the width (trans.) of the pygidium anteriorly. It tapers backwards quite rapidly and terminates in a bluntly pointed end, which does not reach the posterior margin. A short postaxial ridge is present. The axis consists of five rings and a short end piece. In lateral profile the axis slopes down moderately rapidly towards the posterior (see Fig. 4, B), and each axial ring is weakly convex. The pleural areas have four pairs of ribs, with strong pleural and weak interpleural furrows, which turn strongly backwards distally. The pleural furrows deepen considerably distally, and possess a deep anterior slope and a rather shallow posterior slope. The interpleural furrows are narrow and shallow and are only immediately evident distally, although they can be traced inwards almost to the axial furrow.

Dimensions (in millimetres). –

Cranidia.					
Specimen no.	L	L_1	L_2	W	δ–δ
Holotype					
PMO 70437	3.6	2.0	0.8	1.8	2.3
PMO 70497	7.5	4.0	1.5	3.5	?4.8
PMO 70495	6.0	3.4	1.2	2.9	4.0
RM Ar. 37442	4.3	2.5	0.9	2.4	2.8

Pygidia.				
Specimen no.	A	A_1	X	Y
PMO 8695	1.0	0.7	1.7	0.5
PMO 8696	0.9	0.7	?1.8	0.5

Discussion. – The profile of the preglabellar field and glabella is close to that of *Decoroproetus matutinus* (Ruedemann) from the Middle Ordovician of New York State. In most other species of *Decoroproetus* the preglabellar field is concave or sigmoidal in profile. The only information available on the pygidium of *D. solenotus* is from two early holaspid specimens. These have a small number of axial rings (five) and a distinct postaxial ridge. They resemble the transitory and early holaspid pygidia of *Denemarkia frontalis* (see Erben 1966, Pl. 19, Figs. 1–4) and the pygidium of *Phaseolops sepositus* (see Whittington 1963, Pl. 5, Figs. 1–6). In all three a range of common pygidial features is evident; the backwardly turned pleural ribs, the deep pleural furrows and the small number of axial rings. Other parts of the exoskeleton do not correspond so well, but the glabellar outline and the strongly divergent anterior branches of the facial sutures are features shared by all three species. *Phaseolops sepositus* and *Denemarkia frontalis* show far greater similarities to one another than does either of them to *Decoroproetus solenotus*. The similarity of the pygidial and other features might

suggest some relationship, but the age difference between the three species is great (*P. sepositus* Llanvirn, *D. solenotus,* Caradoc and *D. frontalis,* Lower Devonian) and makes any relationship highly unlikely. The resemblance of *Phaseolops sepositus* to undoubted proetids supports Whittington's (1963, p. 40) contention that it is one.

Decoroproetus sp. A

Fig. 6, C, F.

Material. – One cranidium (PMO 61018c), on the same piece of rock as *Frognaspis stoermeri* Nikolaisen (figd. Nikolaisen, 1965, Pl. 2, Fig. 4).

Horizon and Locality. – Upper Chasmops Limestone (4 bδ_2), subzone of *Tretaspis kiaeri;* western side of Frognøy Island, Lake Tyrifjorden, Ringerike.
Description. – The cranidium has the palpebral width about three-quarters of the sagittal length. The glabella is slightly longer (sag.) than it is wide (trans.) and is defined by narrow, distinct, conjoined axial and preglabellar furrows. It is widest at the posterolateral corners, and tapers gradually forwards to the anterolateral corners, with a bluntly angular frontal lobe. The glabella is slightly constricted opposite gamma, and is moderately convex in lateral and longitudinal profiles. Three pairs of lateral glabellar furrows are present, which are weakly impressed on the glabellar surface and interrupt the striated sculpture. 1 p is situated opposite the centre of the palpebral lobe and is directed backwards at about 45° to an exsattigal line. The proximal part is wide, while the distal part is rather narrow, and the whole furrow extends about two thirds of the way towards the sagittal line. 2p is situated opposite the anterior part of the palpebral lobe, and is about the same width as the distal part of 1p, and is directed backwards a little less strongly than 1p. 2p is about the same length as the proximal part of 1p. 3 p is situated just behind the anterolateral corner of the glabella, is about the same length as 2 p and is directed slightly forwards. There is an inconspicuous auxiliary impression associated with 1 p, situated between the proximal part of 1 p and the sagittal line.

The occipital furrow is rather narrow, and is deeper than the axial and preglabellar furrows. It widens slightly about half way beween the sagittal line and the lateral end. The occipital furrow runs transversely for most of its length, and curves forwards slightly at either end. It does not run into the axial furrow due to the fusion of the posterolateral corner of the glabella with the anterolateral corner of the occipital ring. The occipital ring is apparently of about the same width (sag.) as the preglabellar field, and is a little wider (trans.) than the glabella. It apparently maintains more or less the same width along its length (sag. and exsag.), and narrows slightly at the extreme lateral ends. There are no lateral occipital lobes, but there is a small, distinct median tubercle.

The preglabellar field is short (sag.), about one sixth the sagittal length of the glabella. The anterior border furrow is wide and shallow, its position being indicated by the change in slope between the downsloping preglabellar field and the upturned, weakly convex anterior border, which is about four fifths the length (sag.) of the preglabellar field.

The anterior branches of the facial sutures are quite strongly divergent, with gamma close to the axial furrow. Beta forms a wide curve, and an exsagittal line drawn backwards from it falls on the outer margin of the palpebral lobe. The posterior branches of the facial sutures have epsilon close to the axial furrow at the lateral end of the occipital ring. They diverge strongly on the posterior border, and presumably cut the posterior margin close to the base of the genal spine.

The palpebral lobe is rather narrow, crescentic in outline, nearly half the sagittal length of the glabella and backwardly placed. It bends up strongly from the axial furrow and flattens out distally, and is not elevated to the height of the sagittal region of the glabella.

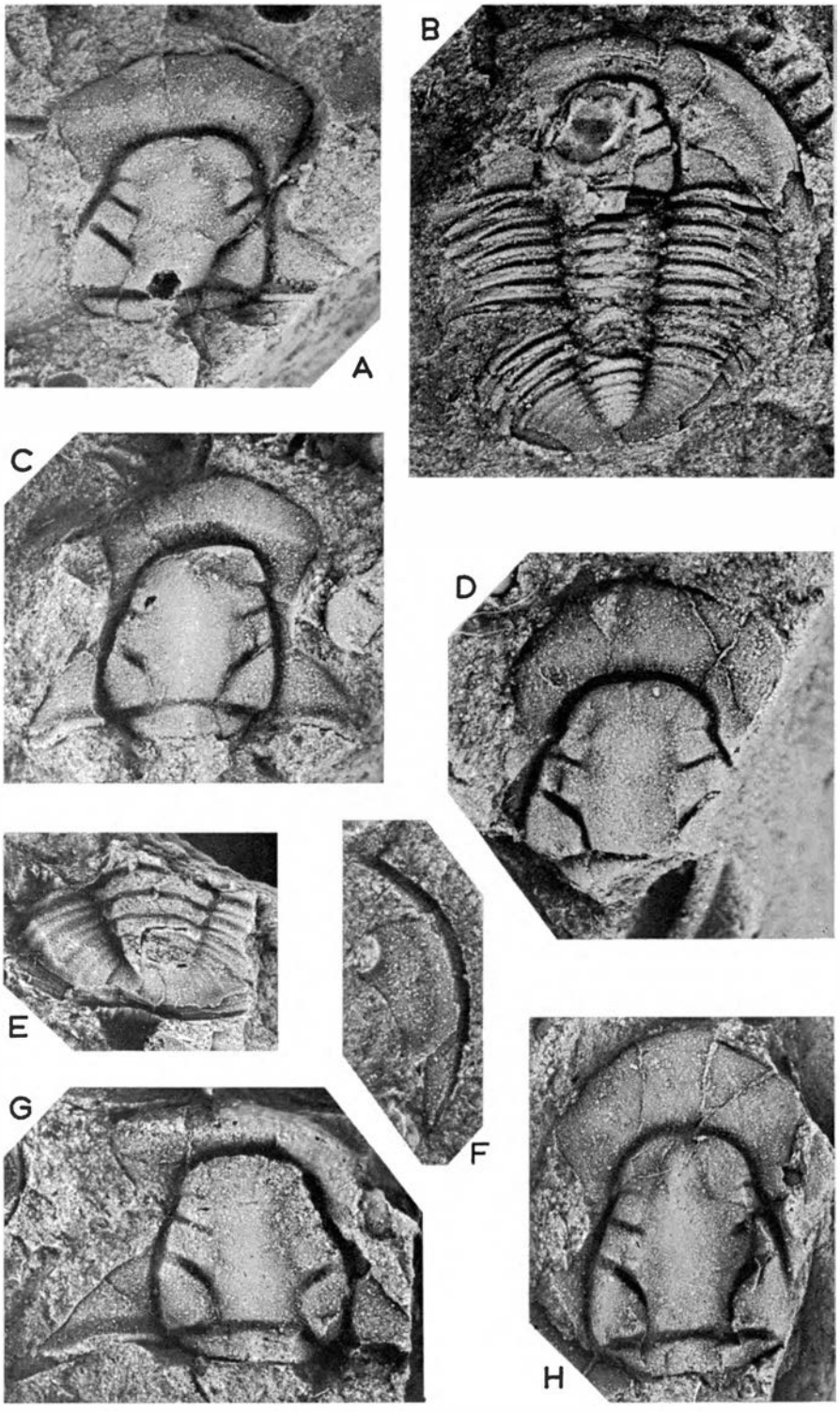
The cranidium has a sculpture of fine, raised striae, arranged in a Bertillon pattern on the glabella and occipital ring. On the preglabellar field they run transversely, on the anterior border inwards and slightly forwards and on the palpebral lobe, forwards and outwards. The striae are interspersed with rows of fine granules on parts of the cranidium, particularly on the lateral parts of the glabella.

Dimensions (in millimetres). –

Specimen no.	L	L_1	L_2	W	δ–δ
PMO 61018c	?3.6	2.4	0.4	2.2	2.7

Discussion. – This single cranidium is the youngest proetid known from the Middle Ordovician of the Oslo Region, and does not particularly resemble the other species described herein. It differs from them principially in the short preglabellar field and in its glabellar outline. These features are

Fig. 8.
Analocaspis ursina gen. et sp. nov.
A, C, D, G, H. Cranidia, dorsal view. A, × 7 (PMO 70451); C, × 7 (PMO 70450); D, × 7 (PMO 70449); G, × 7 (PMO 70453); H, × 6 (PMO 70454).
B. Holotype, a nearly complete exoskeleton, dorsal view, × 7 (PMO 8701).
E. Pygidium, dorsal view, × 6 (PMO).
F. Free cheek, dorsal view, × 9 (PMO 70449, on the same slab as D).
All from the Lower Chasmops Shale (4bα); Bjørnsvikveien, close to the syenite dyke, near Drammensveien at Slependen, Bærum, Oslo-Asker. E coll. R. M. Owens, 1969, all the rest coll. J. F. Bockelie, 1966.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comparable with species from elsewhere, particularly *'Proetus' kullsbergensis* Warburg, 1925 (see Warburg, Pl. 5, Fig. 24), from the Middle Ordovician Kullsberg Limestone and a new species of *Decoroproetus* from the Lower Ashgill of the British Isles. The former species differs from *D.* sp. A. in having the occipital ring markedly narrowing laterally, and the latter in having a more bluntly rounded frontal lobe of the glabella.

Subfamily UNCERTAIN

Genus *analocaspis* gen. nov.

Type species: *Analocaspis ursina* gen. et sp. nov.

Derivation of the name. – From the Greek *an,* no, *alox,* a furrow, and *aspis,* a shield, from the absence of a clearly marked anterior border furrow. Gender: feminine.

Diagnosis. – Cephalic border rather wide, weakly convex and poorly defined; Glabella of trapezoidal outline, with three pairs of deeply impressed lateral furrows; Preglabellar field extremely short (sag.); Eye small, forwardly placed; Anterior and posterior branches of facial suture both divergent, the posterior delimiting a small triangulate posterior portion of the fixed cheek; Thorax of at least nine segments; Pygidium of subparabolic outline, without a border; Axis of six rings, pleural areas with four or five pairs of ribs, which extend almost to the margin.

Discussion. – The taxonomic position of *Analocaspis* is uncertain in relation to other proetids. The deep glabellar furrows and the sagittally widened occipital ring can be compared with other supposed proetids, such as *'?Phaseolops* sp. ind.' (Whittington, 1965, Pl. 19, Figs. 1–5) from the Middle Ordovician Table Head Formation of Newfoundland, but which like *Analocaspis* is hard to place. The interesting genus *Rorringtonia* (type species *R. flabelliforme,* Whittard 1966, Pl. 50, Figs. 8–9) which may be a proetid, bears some resemblance to *Analocaspis,* but differs in several features, notably the narrow anterior border, the parallel anterior branches of the facial sutures, the larger number of rings (ten) on the pygidial axis and the larger number of pygidial pleural ribs (nine).

Apart from the proetids, the only other group to which *Analocaspis* shows any resemblance is the calymenids. Several features of *Analocaspis* are found in the calymenids, notably the small, forwardly placed eyes and the deep lateral glabellar furrows. However, the strongly divergent anterior branches of the facial sutures, the convex anterior border, the number of thoracic segments and the type of pygidium are all proetid rather than calymenid, and thus the similarities to proetids far outweigh those to calymenids. For these reasons *Analocaspis* is considered to be a proetid, but because of its distinct morphology it is not assigned to any established proetid subfamily.

Analocaspis ursina gen. et sp. nov.

Fig. 8, A–H.

Derivation of the name. – From the Latin *ursina,* pertaining to bears, alluding to the name of the type locality, Bjørnsvikveien ('Bears' Bay Road').

Holotype. – An almost complete specimen (PMO 8701), Fig. 8, B.

Material. – 9 cranidia, 1 free cheek and 1 pygidium.

Type stratum and type locality. – Lower Chasmops Shale (4bα), Bjørnsvikveien, close to the syenite dyke, near Drammensveien at Slependen, Bærum, Oslo-Asker district.

Occurrence. – Only known from the type locality.

Diagnosis. – Anterior border furrow almost obsolete; lateral border furrow more clearly defined, but very shallow; Palpebral lobe small, upturned; Posterior branch of the facial suture weakly outwardly convex.

Description. – The cephalon is rather weakly vaulted, more or less semicircular in outline with a poorly defined border. The glabella has a trapezoidal outline and is weakly convex in lateral and longitudinal profiles. It is defined by the deep, conjoined axial and preglabellar furrows, and tapers forwards quite rapidly from its widest point, just behind the 1p furrows. Anteriorly it is bluntly truncated. At its widest (trans.) the glabella occupies about one third of the total cephalic width. Three pairs of deep lateral glabellar furrows are present. 1p is situated opposite epsilon. It is almost obsolete proximally, but deepens rapidly inwards and is bent backwards at an angle of between 45° and 50° from an exsagittal line. Posteriorly it shallows and runs into the occipital furrow, thereby partially isolating triangulate 1p lobes, which are about one third of the glabellar length. 2p is situated opposite the anterior part of the palpebral lobe, is shorter and shallower than 1p, and is bent backwards at a similar angle. 3p is situated a short distance in front of 2p, and is shorter and shallower than the other furrows, running almost straight inwards.

The occipital furrow is about the same depth as the axial and preglabellar furrows, and is arched gently forwards sagittally. In lateral profile the posterior slope is shallower than the anterior slope. The occipital ring widens sagittally, and is narrower at the lateral ends, and lacks lateral lobes. In longitudinal profile it slopes downwards from the sagittal region to the lateral extremities, and in lateral profile is weakly convex.

The preglabellar field is extremely short (sag.). The anterior border furrow is very poorly defined, and is invisible on some specimens (cf. Fig. 8, D and Fig. 8, H). The anterior border is rather wide, and is weakly convex in lateral profile.

The anterior branches of the facial sutures are strongly divergent. On the

holotype and certain other specimens (e. g. Fig. 8, B, D), beta is a rounded curve, while on other specimens (e. g. Fig. 8, C, G), beta is markedly angular. This difference is probably the result of deformation. The posterior branches of the facial sutures run outwards and backwards from the pálpebral lobes, to cut the posterior margin just inside the inner margin of the genal spine, producing a small triangulate posterior portion of the fixed cheek.

The palpebral lobe is well forwards, more or less opposite the 2p furrow. It is situated a little way out from the axial furrow, and is rather small and upturned. The eye is small and reniform. The free cheek is weakly convex in profile, sloping down gently from the eye to the weak, shallow, lateral border furrow. The lateral border is rather wide and weakly convex. The inner part of the posterior border furrow is of comparable depth to the axial furrow, but it rapidly widens and shallows laterally, so that outside the facial suture it is about the same depth as the lateral border furrow. The genal spine is short, broad based and flattened, without a median furrow.

The thorax has at least nine segments, but on the only near complete specimen available (the holotype) it is disarticulated between the sixth and seventh segments. The thoracic axis is weakly convex in longitudinal profile. Anteriorly it is about the same width as the pleural areas, but posteriorly it is rather wider. The axis narrows gently backwards so that the last ring is about three fifths as wide (trans.) as the first. The pleurae run almost straight outwards from the axial furrow, and curve gently backwards distally. Each pleuron has a rather deep, distinct, pleural furrow, which runs almost to the distal extremity. The distal end of the pleuron is pointed.

The pygidium is of subparabolic outline, without a border. Anteriorly the axis is just over one quarter of the pygidial width, and tapers quite rapidly backwards, terminating bluntly and not reaching the posterior margin. It consists of six rings and a short terminal piece. There is no postaxial ridge. The pleural areas have four to five pairs of ribs which bear narrow interpleural furrows and wider, deeper pleural furrows, both of which reach close to the pygidial margin. The pleural furrows divide each pleural rib into an anterior and posterior band of more or less equal width and convexity. The pygidial doublure is rather narrow and dorsally concave.

As far as can be seen, the entire exoskeleton is smooth.

Dimensions (in millimetres). –
Total length (sag.) of holotype (PMO 8701) – 8.1 mm.
Greatest width (trans.) of cephalon of holotype – c. 7.0 mm.
Length of thorax (sag.) of holotype – 2.9 mm.

Cranidia

Specimen no.	L	L_1	L_2	W	δ–δ
Holotype					
PMO 8701	3.5	2.1	0.9	2.6	3.6
PMO 70449	?6.1	3.5	1.9	?4.0	4.0
PMO 70450	5.0	2.5	1.3	3.3	4.0
PMO 70451	5.5	3.1	1.5	3.8	4.1
PMO 70453	?5.5	3.3	?1.0	3.8	4.0
PMO 70454	7.8	4.5	2.4	4.5	4.7

Pygidia

Specimen no.	A	A_1	X	Y
Holotype				
PMO 8701	1.8	1.3	4.0	1.2
PMO	3.7	2.9	?7.0	2.5

Discussion. – *Analocaspis ursina* is the only known species of the genus, and has only been found at the type locality, from where about a dozen specimens have been recovered. All are rather poorly preserved internal moulds, which have suffered some distortion. One specimen (PMO 70454) is proportionately longer and narrower than the other specimens, but these differences are probably due to distortion.

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8th May 1970

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