NEW UPPER CARBONIFEROUS CHELICERATA (ARTHROPODA) FROM SOMERSET, ENGLAND

by T. AMBROSE and M. ROMANO

ABSTRACT. Well preserved arthropods from the Farrington Group (Westphalian D) of the Somerset coalfield are described. Ten specimens of Euproops kilmersdonensis sp. nov., of which seven occur on a single bedding plane, permit a range of intraspecific variation and effects of deformation to be taken into account in erecting a new species. A reconstruction of E. kilmersdonensis does not show the presence of long ophthalmic spines. It resembles the type species, E. danae (Meek and Worthen 1865), differing in the shape of the cardiac lobe and ornament of the opisthosoma. Eophrynus jugatus sp. nov. is the third recorded species of the genus Eophrynus (which is known only in Britain) differing in dorsal and ventral ornament from the type species, Eophrynus prestyici (Buckland 1837).

THE specimens of *Euproops kilmersdonensis* sp. nov. and *Eophrynus jugatus* sp. nov. described in this paper occur in laminated and current bedded grey, silty mudstones with comminuted plant debris associated with the No. 9 coal seam, which is the lowest seam of the Farrington Group in the Somerset coalfield. The Farrington Group is assigned to the *tenuis* Zone, of Westphalian D age.

The material described was found during a field excursion to the Bristol district and was discovered on the mine tip of Kilmersdon Colliery, near Radstock by Messrs. H. Bailey and R. Aldous, students in the Department of Geology, University of Sheffield, who kindly made the material available to the authors.

The genus *Euproops*, Upper Carboniferous to Permian, is widely known from rocks of Westphalian age, and has been recorded from North America and Europe. It is often found associated with fossil arachnids, and is generally regarded as being non-marine. Although specimens of *Euproops* are fairly common in comparison with numbers of other Xiphosura, the occurrence of seven exoskeletons of one species on a single slab (see Plate 112, fig. 1) is unusual and provides an opportunity for investigating intraspecific variation.

Eophrynus jugatus, is, as far as the authors are aware, only the third species of this genus to be described from Britain. Specimens of the first, Eophrynus prestvici (Buckland 1837) have been made available to the authors by Birmingham University and the British Museum. The second, Eophrynus warei (Dix and Pringle 1930) is referred to below.

TERMINOLOGY

The morphological terms for the *Merostomata* proposed by Størmer *in* Moore (1955) have been generally adopted. Some modifications to existing terms are used and other new terms are proposed to facilitate description.

¹denotes proposed new terms

²denotes modified terms

Prosoma Text-fig. 1A

Border-Synonymous with that defined by Harrington et al. in Moore (1959, p. O119).

¹Preophthalmic field—Area lying between the anterior border and cardiophthalmic region and limited laterally by the line running anteriorly (exsag.) from the eye to the border.

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¹Cardiac ridge—Median ridge running from the posterior margin of the cardiac lobe to the mid-point of the anterior branches of the ophthalmic ridges. It need not be continuous.

Cheek—Area of the prosoma lying lateral to the cardiophthalmic region and preophthalmic field, excluding the border and genal spine.

Opisthosoma Text-fig. 1B

²Axis—Medial region of the opisthosomal dorsal exoskeleton, bordered by axial furrows. This proposal thus excludes the term cardiac lobe when referring to the opisthosoma.

¹Pleural rib—Dorsal transverse segment of the lateral portion of the opisthosoma bounded by the axial furrow and excluding the opisthosomal rim (see below).

²Pleural ridge—Ridge separating adjacent pleural ribs.

¹Opisthosomal rim—Flat flange surrounding the central raised portion on all but the anterior margin and crossed by ridges in direct continuation with the pleural ridges.

¹Opisthosomal spine—Laterally to posteriorly directed pointed extension of the opisthosomal rim with a ridge along the posterior margin.

Class MEROSTOMATA Dana, 1852 Order XIPHOSURIDA Latreille, 1802 Family EUPROOPIDAE Eller, 1938 Genus EUPROOPS Meek, 1867

Type species. Euproops danae (Meek and Worthen 1865)

Euproops kilmersdonensis sp. nov.

Text-fig. 2; Plate 112, figs. 1-3; Plate 113, fig. 1

Diagnosis. Euproops with narrow, flat to roll-like border to prosoma; anterior part of cardiac lobe constricted; very short ophthalmic spines. Axis of opisthosoma with tubercle on first and third segment, short spine on terminal segment. Opisthosomal rim moderately narrow with long rim spines. Telson long.

Type material. Holotype. It. 61012 (Pl. 112, fig. 1; Pl. 113, fig. 1). Internal and external mould of nearly complete specimen. Internal mould figured. Paratype. It. 61013 (Pl. 112, figs. 1–3). Internal and external mould of nearly complete specimen. Internal mould figured. Other figured material. It. 61014, external mould; It. 61015, internal mould; It. 61016, external mould; It. 61017, external mould; It. 61018, internal mould. Counterpart of material figured in Plate 112, fig. 1 is retained in the reference collections of the Department of Geology, University of Sheffield.

The specimens figured are in the collections of the British Museum (Natural History) and their numbers are prefixed It.

Horizon and locality. No. 9 seam, Farrington Group (tenuis Zone, Westphalian D). Upper Carboniferous (Moore and Trueman 1937, p. 228). Mine tip at Kilmersdon Colliery (Grid reference ST 681536) near Radstock, Somerset.

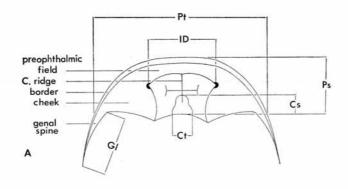
Derivation of name. After the colliery at Kilmersdon where the specimens were found.

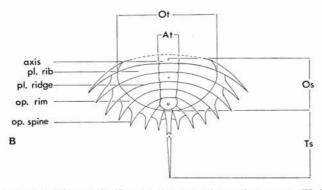
Measurements. Dimensions in mm. (e) denotes estimated.

EXPLANATION OF PLATE 112

Fig. 1. Slab with seven specimens of Euproops kilmersdonensis sp. nov. Specimen 1 Holotype (It. 61012) Internal mould; 2 Paratype (It. 61013) Internal mould; 3–7 Not type material. 3 (It. 61014) External mould; 4 (It. 61015) Internal mould; 5 (It. 61016) External mould; 6 (It. 61017) External mould; 7 (It. 61018) Internal mould.

Figs. 2, 3. Euproops kilmersdonensis sp. nov. Paratype (It. 61013). Internal mould. 2, dorsal view of detail of cardiophthalmic region, ×4. 3, dorsal view of detail of left side of opisthosoma, ×3. Specimens whitened with ammonium chloride before photographing.





TEXT-FIG. 1. Diagram showing measurements taken and new or modified terms for E. kilmersdonensis sp. nov.

Key to Symbols:

- Ps Prosomal length measured in the sagittal line from the posterior margin of the cardiac lobe to the anterior margin.

 Pt Prosomal width measured in a transverse direction along the posterior margin of the cardiac lobe.

 Cs Length of cardiac lobe measured in sagittal line.
- Ct Width of cardiac lobe measured in a transverse direction along the

- posterior margin.

 ID Interocular distance measured in a transverse direction between the eyes.

 G1 Length of genal spine measured along the length of the spine.

 Os Opisthosomal length measured in the sagittal line from the posterior margin of the cardiac lobe to the posterior margin of the opisthosoma.
- Ot Opisthosomal width measured in a transverse direction through the greatest width.
- At Axial width measured in a transverse direction at the anterior end. Ts Length of telson measured along its length.

Abbreviations:

C. ridge Cardiac ridge pl. rib Pleural rib Opisthosomal rim Pleural ridge pl. ridge op. rim op. spine Opisthosomal spine

TABLE 1. Some measurements taken on *E. kilmersdonensis* sp. nov. For explanation of symbols see key to text-fig. 1.

				4	Specime	n				
Symbol	1	2	3	4	5	6	7	8	9	10
Ps	14	14.5	17	13	12.5	12(e)	10.5	_	10.5	21
Pt	36	48	32	41.5	48	53(e)	48(e)		34(e)	36.5
Cs	5.5	4.5	6	5.5	5(e)	5.5	6	-	4.5	7(e)
Ct	5.5	6.5	4.5	5(e)	-	-	5	5(e)	4	
ID	15(e)	18	13(e)	17.5(e)	19	22	18.5	_	12(e)	14
Gl	+12	_	15		+11	_	+11	7000	_	+10
Os	12	10.5	14	10.5	11.5	12.5	-	18	11.5(e)	-
Ot	20	24	27(e)	25(e)	25	27	22(e)	16	17(e)	-
At	5.5	6.5	4	6	6.5	7	-	3.5(e)		
Ts	+17	+15		+10	39		11000		10-22	_

TABLE 2. Some ratios of measurements taken on E. kilmersdonensis sp. nov.

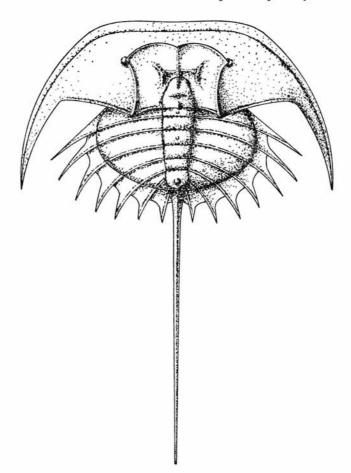
	Ratio								
Specimen	Ps:Pt	Os:Ot	Ps:Os	ID:Pt					
1	1:2.6	1:1.7	1.2:1	1:2.4					
2	1:3.3	1:2.3	1.4:1	1:2.7					
3	1:1.8	1:1.9	1.2:1	1:2.5					
4	1:3.2	1:2.4	1.2:1	1:2-4					
5	1:4.6	1:2.2	1.1:1	1:2.5					
6	1:4.4	1:2.2	1.0:1	1:2.4					
7	1:4.6	_	-	1:2.6					
8		1:0.9		_					
9	1:3.2	1:1.5	0.9:1	1:2.8					
10	1:1.7	-		1:2.6					

Specimens in Tables 1 and 2 numbered 1–7 refer to those in Plate 112, fig. 1; specimens 8–10 from the same mudstone fragment are not figured and are in the reference collections of the Department of Geology, University of Sheffield.

Deformation of the sediment may be approximated to a compression of the mudstones parallel to the transverse axis of specimen 3 (Plate 112, fig. 1) as length to width ratios show greatest variation in specimens 3 and 6 which lie parallel and at right angles respectively to the direction of elongation. Original right angles are distorted in specimens (1 and 2) lying oblique to this direction. The absolute measurements (Table 1) and ratios of measurements taken either along the length or width of the specimens (Table 2) suggest a range of variation consistent with the assemblage being of adults of the same species. The number of specimens available for study does not warrant statistical analysis.

Description. The prosoma is approximately semi-circular in outline with a straight margin anterior to the precardiophthalmic field. The prosomal border is narrow, widest (sag.) anteriorly and flat to gently roll-like in cross section. The narrow doublure is widest anteriorly and continues with the border along the genal spine. The cardiophthalmic region is gently convex dorsally; the narrow (sag.) precardiophthalmic field slopes steeply down to anterior border. The cheeks are fairly wide (trans.) and slope gently outwards. There is a narrow (exsag.) border and shallow furrow along the posterior margin of the prosoma.

The cardiophthalmic region is delimited by prominent ophthalmic ridges. Anterior to the eyes the ophthalmic ridges form a double arch; posterior to the eyes the ridges are concave outwards and continue backwards to protrude just beyond the posterior



TEXT-FIG. 2. Reconstruction of *Euproops kilmersdonensis* sp. nov. based on holotype and paratype. Dorsal view: ×2 (length of telson taken from specimen It. 61016, see Plate 112, fig. 1).

margin as short spines (less than 1 mm in length). The distance between the ophthalmic spines is slightly less than the interocular distance. The cardiophthalmic region shows considerable wrinkling of the exoskeleton in all specimens but there is a fairly continuous transverse ridge in most which crosses the area anterior to the cardiac lobe and

just posterior to the eyes, and dies out laterally before reaching the ophthalmic ridges. In a few specimens traces of other ridges within the cardiophthalmic region make an 'H' shaped pattern with the transverse ridge described above as the connecting ridge. The cardiac lobe is sub-triangular in outline with a nearly straight anterior margin and approximately as wide as long. The sides of the cardiac lobe converge quite strongly at about midlength and anterior to this the sides are more parallel sided. The cardiac lobe is bounded by a shallow furrow except anteriorly where the cardiac ridge crosses the furrow and continues to the anterior branch of the ophthalmic ridge. The cardiac ridge terminates at a distance of approximately one-third the length of the cardiac lobe from the anterior end and is represented by a small tubercle at the posterior end of the lobe. At about the midlength of the lobe a broad (sag.) shallow transverse furrow may occasionally be seen (Pl. 112, fig. 2). The eyes are rarely preserved, and occur as small convex tubercles (0.5 mm across). Long, slightly curved genal spines are directed posteriorly or posterolaterally reaching to the posterior margin of the opisthosoma. The prosomal border continues along the genal spines. The central raised portion of the opisthosoma is oval in outline with maximum width at just under one-third the distance from the anterior margin. The axis is widest anteriorly where it is about the same width as the cardiac lobe along the posterior margin, narrowing slightly posteriorly to the expanded terminal segment. The axis is gently convex (trans.) and bordered by shallow furrows. Five axial rings of about the same length (sag.) are developed and separated by shallow furrows. The terminal segment is globular in shape, standing above the axial rings and not quite reaching the opisthosomal rim. The first and third axial rings bear a small median tubercle; the terminal segment has a short centrally placed spine. The pleurae are fairly flat except near margin where they are steeply downturned. In some specimens (Pl. 113, fig. 1) a distinct geniculation on the pleurae exists along a line in continuation with the ophthalmic ridges (see Discussion). Up to seven pleural ribs are present, becoming narrower (exsag.) and directed more backwards towards the posterior end. The opisthosomal rim is moderately narrow with seven long, slender, gently curved opisthosomal spines. The more posterior spines are shorter and directed more backwards. Pleural ridges separating the pleural ribs pass along the posterior edge of the spines (Pl. 112, fig. 3).

The telson is long, slightly carinate, and reaches to nearly twice the length of the body. The telson is ornamented with numerous fine, discontinuous, wavy ridges running oblique to the length.

Discussion. Euproops kilmersdonensis sp. nov. differs from E. rotundatus (Prestwich) in several important characters. The cardiac ridge of E. rotundatus continues along the length of the cardiac lobe to the posterior margin whereas in E. kilmersdonensis the ridge is interrupted by a transverse furrow at about the midlength of the lobe. The major differences however are on the opisthosoma where in E. rotundatus the opisthosomal rim

EXPLANATION OF PLATE 113

Fig. 1. Euproops kilmersdonensis sp. nov. Holotype (It. 61012). Internal mould of nearly complete individual. Dorsal view, ×2·4. Specimen whitened with ammonium chloride before photographing. Fig. 2. Eophrynus jugatus sp. nov. Holotype (It. 61019). Internal surface of dorsal part of abdomen with part of ventral exoskeleton attached. Ventral view, ×4. Specimen whitened with ammonium chloride before photographing.

is relatively wider and the opisthosomal spines much shorter than in the species from Kilmersdon. According to a reconstruction of *E. rotundatus* by Størmer (*in* Moore, 1955, fig. 12) the prosoma does not show a border. However, two syntypes of *E. rotundatus* (figured in Woodward 1878, pl. XXXI, fig. 5, and Prestwich 1840, pl. 41, fig. 7) have a narrow roll-like border to the prosoma. Størmer's reconstruction also illustrates the presence of long ophthalmic spines that extend posteriorly to the terminal segment. Woodward though, in his drawing of that species (op. cit. pl. XXXI, fig. 5) does not put in any such spines and an investigation of the syntypes of *E. rotundatus* suggests that the spines are not present. However, there is in the syntype described by Woodward a geniculation in the opisthosoma which is in line with the opisthosomal ridges (see also in *E. kilmersdonensis*) and it is this which probably led to the misconception of long ophthalmic spines. Ophthalmic spines are not present in any specimen of *E. rotundatus* studied by the authors although they do occur in *E. orbicularis* Van der Heide (1951, p. 62, pl. 8, figs. 1–4). It is possible that the new material available to Størmer did show ophthalmic spines, but he does not state on what material his reconstruction was based.

Another discrepancy between Woodward's description and the reconstruction in Moore (1955) concerns the ornament on the opisthosomal axis. According to Woodward (although not shown too well on his figure) 'each somite is ornamented on the median line with a single blunt tubercle, a somewhat larger tubercle marks the coalesced and rudimentary abdominal portion' (op. cit., p. 247) while in Størmer's reconstruction tubercles are shown only on the first and third segments with an elevated boss or short spine on the hindmost segment. The syntypes show that Woodward was mistaken in stating that each somite was ornamented.

The type species for the genus, E. danae (Meek and Worthen) (Raymond 1944, p. 484; 1945, p. 4, pl. 1, figs. 1, 2, pl. 2, figs. 1, 2: Langford 1963, p. 25, figs. 27–38) a well known and documented species, is common in the Pennsylvanian of the Mazon Creek area, Illinois, U.S.A. The prosomata of E. danae and E. kilmersdonensis are very similar; both show the border, 'H' shaped structure or ridges within the cardiophthalmic region and interruption of cardiac ridge on the cardiac lobe (see especially Raymond, 1945, pl. 1, fig. 1). However, the anterior margin of the cardiac lobe is much straighter in the present species (compare the reconstruction of Langford's 1963, fig. 27a, with the specimen in Pl. 112, fig. 2). In Langford's reconstruction of E. danae ophthalmic spines reach backwards to the posterior end of the fourth axial segment. On examination of figured specimens of E. danae only five segments appear to be present (excluding terminal segment) and on none are opisthosomal spines visible. Differences on the opisthosoma are more marked between the two species. E. danae has a tubercle on each of the axial segments and in most figured specimens the opisthosomal rim is relatively narrower and the spines shorter than in E. kilmersdonensis. Raymond's species E. thomsoni (Raymond 1944, p. 486, fig. 1) is stated by that author as being similar to E. danae but 'relatively more narrow headed'. Langford (op. cit., p. 29) commented on the uncertainty of E. thomsoni as a valid species based on such a character which depends to a large extent on preservation. The authors agree with Langford's conclusions, especially since the present material shows widely varying length to width ratios depending on the orientation of the specimens in the deformed sediment.

E. amiae Woodward (1918, p. 465, figs. 2-4) from the Coal Measures of Glace Bay Mines, Nova Scotia, is difficult to compare with the present species from Woodward's

drawings, but it differs mainly in shape of cardiac lobe, narrowing of the axis posteriorly and absence of a swollen terminal segment.

Dix and Pringle (1929) recorded a number of species of *Euproops* from the South Wales Coalfield but unfortunately no photographs were included in their paper. Their inadequate descriptions and line drawings do not allow a close comparison to be made with the present material.

Class Arachnida Lamarck 1801 Order Trigonotarbida Petrunkevitch 1949 Family Eophrynidae Karsh 1882 Genus Eophrynus Woodward 1871

Type species. Eophrynus prestvici (Buckland 1837)

Eophrynus jugatus sp. nov.

Plate 113, fig. 2

Diagnosis. Eophrynus with length of abdomen slightly greater than width. Dorsal exoskeleton of abdomen with one pair of large median tubercles on each sclerite, and ornament equigranular across entire width. Paired median ridges on ventral abdominal sclerites.

Type material. Holotype. It. 61019 (Pl. 113, fig. 2). Internal and external mould of nearly complete specimen. Material figured shows internal surface of dorsal part of abdomen with part of ventral exoskeleton attached. The counterpart is retained in the reference collections of the Department of Geology, University of Sheffield.

Horizon and locality. No. 9 seam, Farrington Group (tenuis Zone, Westphalian D), Upper Carboniferous (Moore and Trueman 1937, p. 228). Mine tip at Kilmersdon Colliery (Grid reference ST 681536) near Radstock, Somerset.

Derivation of name. From the Latin jugum, meaning a yoke or ridge, referring to the ornament on the ventral exoskeleton.

Description. The abdomen is 14.5 mm wide and 17 mm long. It has an evenly rounded posterior margin with greatest width at the midlength. Four conical smooth posterior spines are present, the median pair being slightly longer (2.5 mm) than the lateral ones. Each dorsal sclerite is ornamented by three pairs of tubercles, circular in outline and evenly covered by small granules. The ventral exoskeleton is composed of slightly overlapping sclerites, each of which is ornamented by a pair of transverse median ridges, more prominent towards the posterior end of each sclerite, and less regularly spaced lateral paired ridges. Part of the margin of the carapace is preserved and is ornamented by large tubercles and small granules like those of the abdomen. The legs are poorly preserved, but appear similar to those of Eophrynus prestvici. The first right walking leg is the most completely preserved appendage, 18.5 mm in length and 2 mm wide at the proximal end. Ornament on the appendages varies from randomly placed granules on the distal segments to a rough ordering into transverse rows on the proximal segments.

Discussion. Apart from the type and present species, E. warei (Dix and Pringle 1930, p. 142) is the only other species assigned to Eophrynus. The holotype of E. warei is far from complete and according to Petrunkevitch (1953, p. 77) is of doubtful generic affinities.

The present species can be assigned to *Eophrynus* (Petrunkevitch, *in* Moore 1955, p. P112) and is discussed with reference to Buckland's figured material of *E. prestvici* (Buckland, 1837, p. 77, fig. 2) and a cast of the specimen figured by Woodward (1871) and elsewhere (see Petrunkevitch 1953, p. 76).

The dorsal ornament of *E. prestvici* in the median area is composed of coarse granules which may be one-quarter to one-half of the diameter of the smaller tubercles. The border and area around the lateral tubercles is ornamented by a larger number of much smaller granules. The granular ornament of *E. jugatus* is equal in size over the whole dorsal surface. The median tubercles of *E. jugatus* are developed as a single pair on each sclerite. They are not, as in *E. prestvici*, partly coalesced with a second anterior pair of smaller sub-triangular tubercles. *E. jugatus* shows on the ventral surface pairs of rounded (*trans.*) median ridges, more prominent at the posterior end and developed on each of the four sclerites preserved. No such ornament occurs in the ventral sclerites of *E. prestvici*. Petrunkevitch (1953, p. 77) rightly remarks that the ventral ornament indicated on Pocock's figure (1902, fig. 1, p. 490) is an impression of the dorsal tubercles. This is also seen on the present material. The presence of lateral tubercles in addition to the granular tubercles on the carapace of *E. jugatus* is a further difference from *E. prestvici*.

The abdomen of *E. jugatus* differs from that of *E. prestvici* in that it is slightly narrower (*trans.*) relative to its length. The shape of the abdomen is different, the widest part of *E. jugatus* being approximately at the midlength whereas in *E. prestvici* it is nearer the posterior margin.

Although the four posterior spines in *E. jugatus* are 50% longer than those of Woodward's specimen, Buckland's specimen of *E. prestvici* referred to above has spines slightly longer even than those of *E. jugatus*.

CONCLUSIONS

The finding of seven randomly orientated specimens of *Euproops kilmersdonensis* on one bedding plane illustrates well the inadvisability of defining a species solely on length and width ratios when the rocks may have undergone deformation.

The great majority of fossil arthropoda from the upper Carboniferous have been found preserved in nodules. Most of the figured American and British specimens of *Euproops*, and other specimens studied by the authors from the British Museum (Natural History) and the Sheffield City Museum are preserved in this way. The nodules range in size from 3 cm to 15 cm in diameter, and often in the case of the smaller ones the circular shape of a nodule has preserved only an incomplete telson; in others the telson was evidently detached and not preserved with the body of the fossil.

The specimen of *Euproops kilmersdonensis* which is preserved with a complete telson (pl. 112, fig. 1, specimen 5) shows a greater relative length of the telson than has been observed in other material or reconstruction.

The Kilmersdon fossils are unusual in that they all occur on bedding planes in a grey silty mudstone, which has preserved the original material of the exoskeleton, and shows

finer structures than can normally be distinguished on casts preserved in nodules. The single exception to this is the very perfect preservation of *Eophrynus prestvici* described by Woodward 1871.

Euproops kilmersdonensis appears to be more closely related to the American species of Euproops danae than to any previously described British species. This similarity to American fossils is also reflected in the associated floras which, during Westphalian D times bear close comparison with those of the Eastern United States (Dr. R. H. Wagner, pers. comm.).

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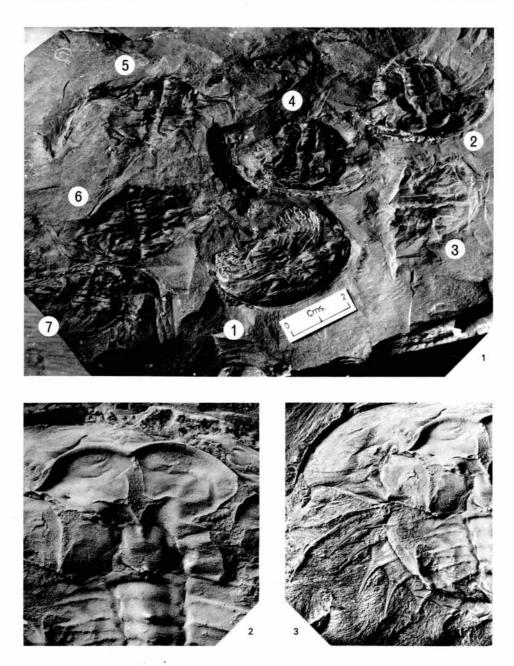
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