

REVISION OF THE ANOMOCARIDS FROM THE CAMBRIAN OF KASHMIR

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ABSTRACT

The trilobite genus *Anomocaraspis* Ivshin constitutes an important element of the Middle Cambrian sequences of the Asiatic province and is widely distributed in the Himalayan succession. The species earlier described by Reed (1934) as *Anomocare hundwarensis*, *Anomocare dimotum*, *Anomocare suspectum* and *Anomocare novatum* have all been grouped together as a single species under the genus *Anomocaraspis* and only one other species described by Reed (1934) as *Anomocare perfunctum* has been retained separately due to its difference in the palpebral lobes and outer rim. In addition to these, two new species viz., *Anomocaraspis kupwarensis* and *Anomocaraspis globosa* have been identified.

INTRODUCTION

The various species of the genus *Anomocare* described by Reed (1934) from the Middle Cambrian sequence of NW Kashmir as listed below were based on cranidia except for *Anomocare hundwarensis* where the complete exoskeleton is preserved.

Anomocare hundwarensis Reed, 1934

Anomocare dimotum Reed, 1934

Anomocare suspectum Reed, 1934

Anomocare novatum Reed, 1934

Anomocare perfunctum Reed, 1934

Anomocaraspis hundwarensis Ivshin, 1953

Ivshin (1953) revised the various species of *Anomocare* and erected a new genus *Anomocaraspis* with *Anomocare hundwarensis* Reed as its type species. On the basis of a distinct glabellar furrow, Kobayashi (1962) grouped *Anomocare hundwarensis* under the genus *Koptura*. This genus has longer preglabellar field and narrow pygidium. None of these characters are seen in *A.hundwarensis*. So the possibility of grouping this with *Koptura* does not seem to be valid. Moreover, the species cannot be placed in *Eymekops* Kobayashi 1944 because in *Eymekops* preglabellar field is relatively short and the glabella is quadrate, while in *Anomocaraspis* preglabellar field is convex, glabella is conical to subcylindrical in shape, palpebral lobe small and the ratio of the length of anterior border with respect to preglabellar field is between 0.5-0.6.

Kobayashi (1962,p.113) stated that all the species described by Reed from Kashmir as *Anomocare* except *A. hundwarensis* may be congeneric with *Hundwarella personata* Reed. But *H. personata* shows bifid posterior pair of glabellar furrows, which is not the case with *A. suspectum*, *A. dimotum*, *A. novatum* or even with *A. perfunctum*. Hence the question of them being congeneric with *H. personata* does not arise. It is, therefore, clear that *Anomocaraspis* as named by Ivshin is a valid

assignment and there is no reason to assign the species either to *Anomocare*, *Eymekops* or *Koptura*.

Anomocare perfunctum is the only species that has validity to remain as a separate species due to the fact that it has relatively small palpebral lobes, subconical anterior border which is thicker at middle and arched toward front which differentiates it from *Anomocaraspis hundwarensis*.

Anomocaraspis hundwarensis is the type species since the generic characters are all seen in it. The species *Anomocare dimotum*, *A.suspectum* and *A.novatum* can all be considered synonyms.

The qualitative characters discussed in remarks also show that all the species described by Reed (1934), except *A. perfunctum*, belong to a single species.

During the course of present studies, the anomocarids were obtained in a tolerable state of preservation from the Middle Cambrian sequence in Zachaldor and Kandi-Nutunus sections of Pohru valley-Kupwara District, NW Kashmir (fig.1). The following taxa have been identified and are being revised.

Anomocaraspis hundwarensis (Reed), *Anomocaraspis perfuncta* (Reed), *Anomocaraspis kupwarensis* n. sp. and *Anomocaraspis globosa* n. sp.

STRATIGRAPHIC DISTRIBUTION AND SIGNIFICANCE

The anomocarids constitute the most abundant elements of the Middle Cambrian fauna of Kashmir. While the taxonomy indicates that the number of species is limited, the population and the distribution is profuse and widespread. Because of this, several earlier authors (notably Reed) were tempted to oversplit the taxa into several species. The biostratigraphic classification of Kashmir Cambrian was given by Shah (1982) wherein it was recognized that a nearly complete sequence of Lower and Middle Cambrian and a small thickness of Upper Cambrian was deposited. The subsequent description of agnostids and other stratigraphically sig-

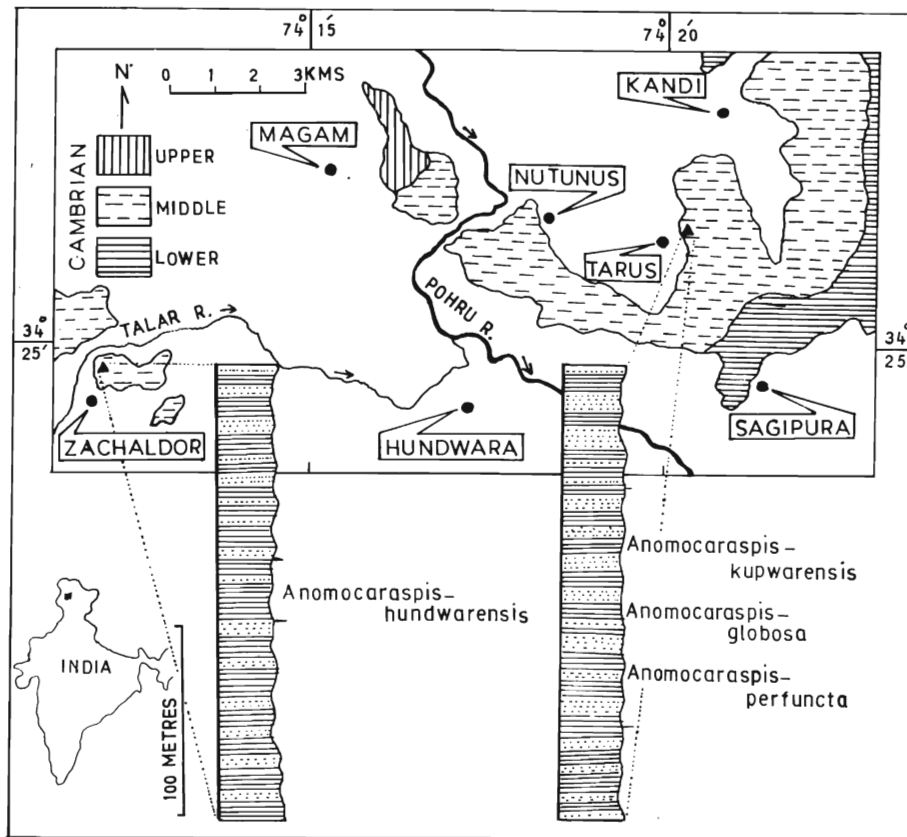


Fig. 1. Geological sketch map of the area with measured stratigraphic columns indicating the stratigraphic position of anomocarids in Zachaldor and Kandi (Tarus) - Nutunus Sections.

nificant polymerids (Shah and Sudan, 1982, 1987a, 1987b) confirmed this and it was possible to correlate the zones with those of other Cambrian sequences in China, Australia and Kazakhstan.

The anomocarids of Kashmir bear a strong affinity to those of Kazakhstan. While anomocarids are known throughout Middle Cambrian, in Kashmir they are essentially restricted to the equivalents of Menevian (upper Middle Cambrian) part of the sequence which comprises *Tonkinella* - *Anomocaraspis* and *Anomocaraspis-Bailiella* Zones.

REPOSITORY

The repository of the material is the Palaeontological Museum in the Geology Department of Jammu University bearing numbers KUF 686-97 and KUFH 75,87,89 & 91.

SYSTEMATIC DESCRIPTION

Class **Trilobita**

Order **Ptychoparida** Swinnerton, 1915

Suborder **Ptychoparina** Richter, 1933

Superfamily **Anomocaracea** Poulsen, 1927

Family **Anomocaridae** Poulsen, 1927

Genus **Anomocaraspis** Ivshin, 1953

Diagnosis: Cephalon subcircular to semi-oval in outline; moderately convex anterior border; glabella conical to subcylindrical, three pairs of short lateral furrows present, palpebral lobes large, crescent shaped; the ratio of the length of anterior border versus preglabellar field about 0.6; genal angles acutely angular; thorax composed of nine segments; pygidium small, pygidial border gently convex, nearly of uniform width.

Remarks: There is some similarity between *Anomocaraspis* and *Anomocare* sensu stricto. However, in the present work, they are regarded as different genera mainly because the European anomocarids in general and *Anomocare* in particular include all kinds of forms which need drastic revision. As against that *Anomocaraspis* has a distinct shape of anterior border, relatively arcuate palpebral lobes, flat or convex preglabellar field, wider fixigenae and larger pygidium and in these characters it is different from *Anomocare*.

Type species - *Anomocare hundwarensis* Reed, 1934

Anomocaraspis hundwarensis (Reed)

(Pl.I, figs. 2,5; fig. 2.1)

Anomocare hundwarensis Reed, 1934; Pl. I; fig. 2
Anomocare suspectum Reed, 1934; Pl. I; fig. 19
Anomocare dimotum Reed, 1934; Pl. I; fig. 20
Anomocare novatum Reed, 1934; Pl. II; fig. 4
Koptura hundwarensis Kobayashi, 1962, p. 110.
Eymekops hundwarensis Kobayashi, 1944 (In Kobayashi, 1967, p. 490)
Anomocaraspis hundwarensis Ivshin, 1953, p. 125
Anomocaraspis novatum Ivshin, 1953
Koptura hundwarensis Kobayashi, 1962, p. 110
Anomocaraspis suspectum Kobayashi, 1962, p. 112
Anomocaraspis novatum Kobayashi, 1962, p. 111
Anomocaraspis dimotum Kobayashi, 1962, p. 110

Material: One complete exoskeleton and five cranidia preserved in greenish shale.

Description: Exoskeleton elongated in outline; cephalon semi-oval, maximum width near the palpebral lobes; cranidium moderately convex, having length slightly greater than the width; glabella convex, sub-cylindrical, frontal margin slightly rounded, three pairs of lateral furrows present, anterior pair and median pair faint and short, posterior pair oblique and well marked; axial furrows deep; occipital furrow shallow, occipital ring moderately wider at middle; palpebral lobes large, crescent shaped and situated opposite the mid-length of glabella; preglabellar field moderately sloping towards the border furrow; anterior border convex in outline and nearly of uniform width; the ratio of the length of anterior border versus preglabellar field about 0.6; palpebral area of fixigene about 1/2 the width of glabella at middle, anterior area of fixigenae wide, posterior area quite narrow and strap-like; librigenae gradually sloping down toward the outer margins and bear long genal spines running almost parallel to the axis; thorax composed of nine segments; axis convex, raised above the level of pleural fields; pleural furrows shallow; pygidium small, subtriangular in outline with axis tapering posteriorly; pleural field wider than the axis in width, pleural furrows shallow extending obliquely outwards separating five pleurae on each side.

Remarks: The species presently described as *Anomocaraspis hundwarensis* was placed in the genus *Anomocare* by Reed. The concave preglabellar field, narrow fixigenae and very small pygidium are the diagnostic characters of *Anomocare* and these are not seen in the species described by Reed.

Reed (1934) erected several species viz., *Anomocare hundwarensis*, *A. suspectum*, *A. novatum*, *A. dimotum* and *A. perfunctum*. But the qualitative characters discussed below show that *A. hundwarensis*, *A. dimotum*, *A. suspectum*, *A. novatum* constitute a single species.

Dimensions (in mm) :

	KUFH	KUFH	KUFH	KUFH
	75	87	89	91
Length of complete exoskeleton.	11.5	-	-	-
Length of cranidium.	4.5	4.5	4.5	4.5
Width of cranidium at palpebral lobes.	4.0	3.5	4.0	4.0
Length of glabella.	3.0	3.0	3.0	3.0
Basal width of glabella.	2.0	1.5	2.5	2.0
Preglabellar field (length).	0.9	0.9	0.9	0.9
length of anterior border at middle	0.6	0.6	0.6	0.6
Length of thorax.	4.5	-	-	-
Length of pygidium.	2.5	-	-	-
Anterior width of pygidium.	3.0	-	-	-
Length of axis of pygidium.	2.0	-	-	-
Frontal width of the pygidial axis.	1.5	-	-	-

The quantitative characters were studied for determining the affinities. The quantitative ratios chosen are total cranidial length versus total glabellar length and the total glabellar length versus total frontal area (i.e., preglabellar field plus anterior border). The ratios taken from specimens described by Reed (1934) and also from the presently available specimens are indicated below :

	*	*
	b/a	c/b
<i>Anomocaraspis hundwarensis</i> (Reed)	0.62	0.52
<i>Anomocaraspis perfunctum</i> (Reed)	0.64	0.52
<i>Anomocaraspis kupwarensis</i> n. sp.	0.64	0.54
<i>Anomocaraspis globosa</i> n. sp.	0.66	0.52

* (a = total length of cranidium, b = total length of glabella, c = total frontal area)

The ratio of total cranidial length versus total glabellar length is about 0.6, while the ratio of total glabellar length versus total frontal area is 0.5.

Obviously these ratios correspond in all these species. There seems to be no quantitative justification to separate them. *A. perfunctum* as such is the only species that has validity to remain as a separate species in having relatively smaller palpebral lobes and in the outline of

Dimensions (in mm) :

	KUF	KUF	KUF	KUF	KUF	KUF	KUF
Cranidium	686	687	688	689a	689b	690	691
Length of cranidium. 8.0	10.0	8.5	7.5	8.5	10.5	9.0	
Width at palpebral lobes.	6.5	8.0	6.5	6.0	7.0	8.0	7.5
Length of glabella.	5.0	6.5	5.5	5.0	5.5	7.0	6.0
Width of glabella at base.	3.0	4.0	2.5	2.5	2.5	4.0	3.0
Preglabellar field length.	1.0	1.5	1.0	1.0	1.0	1.5	1.0
length of anterior border at middle	2.0	2.0	2.0	1.5	2.0	2.0	2.0

anterior border which is arched toward front, subconical and thicker at middle.

It is, therefore, clear that *Anomocaraspis* as named by Ivshin is a valid assignment and there is no reason to assign the species either to *Anomocare*, *Eymekops* or *Koptura*. So, all the species of *Anomocare* described by Reed are assigned to one species as *Anomocaraspis hundwarensis* except *A.perfunctum*, which can be considered a distinct species of *Anomocaraspis*.

Horizon and locality : The specimens were collected from the Zachalдор section from *Tonkinella-Anomocaraspis* Zone.

Anomocaraspis perfuncta (Reed)

(Pl.I, figs., 1, 3,7,11,12; fig.2.3)

Anomocare perfunctum Reed,1934;Pl.I;figs.15-18*Anomocaraspis perfunctum* Ivshin,1953, p.125*Anomocaraspis perfunctum* Kobayashi,1962, p.111*Material* : Ten cranidia in brown friable shale.

Description : Cranidium semi-oval in outline, length greater than the width; glabella convex, elongate, tapering anteriorly, subrounded in front; three pairs of lateral glabellar furrows present, faint on some specimens; axial furrows deep, well defined; occipital furrow shallow, wider and moderately arched forward at middle, occipital ring nearly of uniform width; palpebral ridges well marked and start obliquely outward from the base of the anterior pair of glabellar furrows, palpebral lobes small and situated opposite the centre of glabella; fixigene convex, raised up to the level of glabella and about 0.7 the width of glabella at middle; preglabellar field present; anterior border furrow shallow and arched moderately in front, anterior border elevated, longer at middle and narrowing towards lateral sides, outer margin of the anterior border subconical in outline; the ratio of the preglabellar field and the median length of anterior border nearly 1:1.5 to 1:2; facial sutures above the palpebral lobes sub- parallel, posterior branches

divergent; surface of the cranidium bearing fine granules.

Remarks : The specimens correspond to *Anomocaraspis perfuncta* in the cranidial morphological characteristics especially in the smaller palpebral lobes, elongated glabella, outline of the anterior border and in the course of facial sutures. Although the irregular pit-like lateral glabellar furrows are not so prominent but the faint traces are visible on some specimens.

They differ from *Anomocaraspis hundwarensis* in the longer anterior border (sagital) with a subtriangular outer margin, relatively smaller palpebral lobes and in the presence of fine granules on the outer surface of the cranidium.

Horizon and locality : Specimens were collected from the Kandi (Tarus) - Nutunu section from *Tonkinella - Anomocaraspis* Zone.

Anomocaraspis kupwarensis n. sp.

(Pl.I, figs. 6,8,9; fig.2.2)

Etymology : The species is named after the Kupwara district from where the type specimens have been collected.

Material : Six cranidia in brown friable shale.

Diagnosis : Cranidium with length greater than its width; glabella subrectangular with three pairs of lateral furrows, posterior pair transglabellar and aligned in a U-shape at the mid-width of glabella; palpebral lobes large and sickle shaped; palpebral area of fixigene less than half the mid-width of glabella; preglabellar field wide; anterior border furrow shallow; the ratio of the length of anterior border with respect to the preglabellar field nearly 1:1.5. Thorax and pygidium unknown.

Description : Cranidium elongated in outline, length greater than the width at palpebral lobes; glabella convex, subrectangular, rounded in front, marked by three pairs of lateral glabellar furrows, anterior pair faint, median pair short, posterior pair well developed, trans-

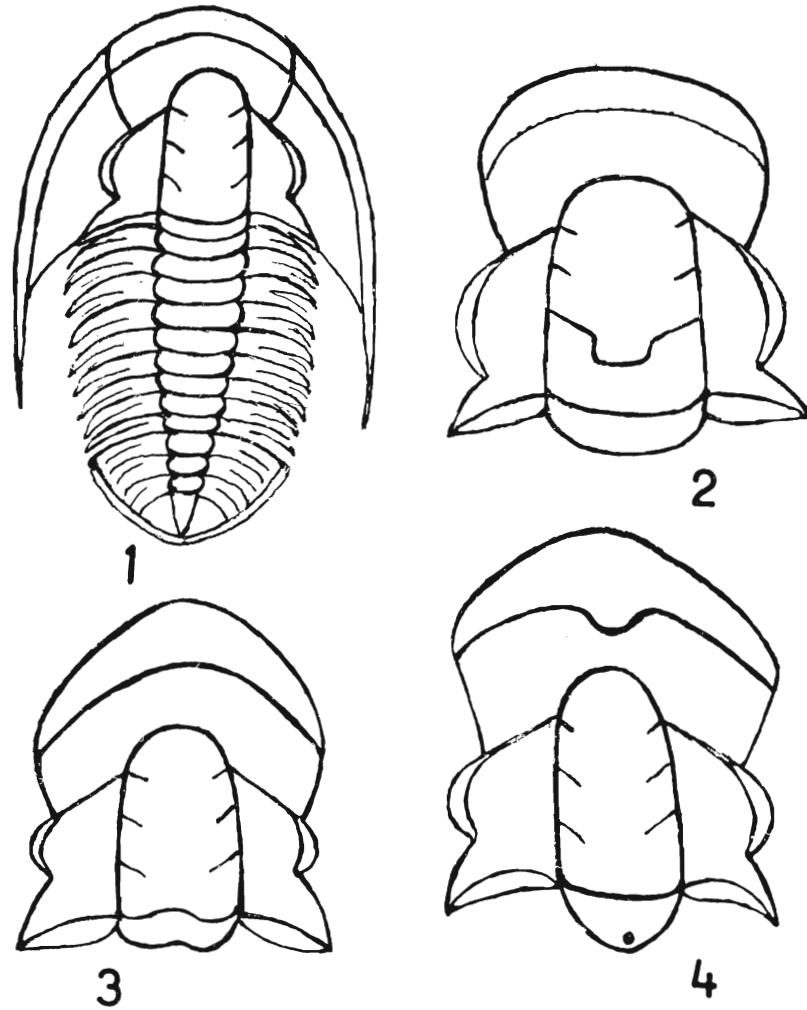


Fig. 2. (Camera lucida hand sketches of representative specimens)

1. *Anomocaraspis hundwarensis* (Reed) Complete exoskeleton x 6.1
2. *Anomocaraspis kupwarensis* n.sp. Cranidium x 6.2
3. *Anomocaraspis perfuncta* (Reed) Cranidium x 5.5
4. *Anomocaraspis globosa* n.sp. Cranidium x 6.5

glabellar, making a U-shaped outline at the mid-width of glabella; occipital furrow shallow, occipital ring nearly of uniform width, moderately arched backward; palpebral ridges well marked and start obliquely outward from the base of the anterior pair of glabellar furrows, palpebral lobes large, sickle shaped and situated opposite the centre of glabella; palpebral area of fixigene short and about 0.4 the mid-width of glabella, anterior area broader, posterior area narrow, strap-like; preglabellar field wide and sloping gradually forward; a narrow but faint trace of anterior border furrow visible from where the anterior border starts rising upward, anterior border nearly of uniform width with convex outline; the ratio of the preglabellar field with respect to the length of anterior border nearly 1.5:1; anterior branches of facial sutures sub-parallel, scarcely diver-

gent, posterior branches diverge obliquely outward from the rear end of the eye lobes to reach the posterolateral ends of the head shield. Thorax and pygidium unknown.

Remarks: The specimens differ from the known species of *Anomocaraspis* mainly in the subrectangular outline of the glabella, transglabellar nature of the posterior furrow characteristically U-shaped in the middle and in the large eye lobes.

Horizon and locality: Specimens were collected from the Kandi (Tarus) - Nutunus section from *Tonkinella* - *Anomocaraspis* Zone.

Anomocaraspis globosa n. sp.

(Pl.I, figs. 4,10; fig.2.4)

Etymology : The name is derived from globosus (Latin word meaning round or spherical), referring to the swollen boss on the anterior border which characterises this species.

Material : Two cranidia in brown shale.

Diagnosis : Cranidium longitudinally sub-rectangular, glabella occupies about 2/3rd part of the length of cephalon, occipital ring wider in the middle, strongly arched backward and also bearing a small node at posterior end; anterior border swollen, with a median boss, outer margin of the anterior border giving a sub-triangular appearance. Thorax and pygidium unknown.

Dimensions (in mm) :

	KUF 694a	KUF 995b	KUF 695b	KUF 696a	KUF 696b
Cranidium					
	(Holotype)				
Length of cranidium	8.5	8.5	7.5	8.5	5.5
Width at palpebral lobes	7.0	7.0	6.0	7.0	4.0
				(anterior Width)	
Length of glabella	5.5	5.5	5.0	5.5	3.5
Basal width of glabella	3.5	3.5	3.5	4.0	2.5
Preglabellar field	1.8	1.8	1.5	2.0	1.2
Length of anterior border at middle	1.2	1.2	1.0	1.0	0.8

Description : Cranidium longitudinally sub-rectangular in outline, length greater than width; glabella convex, tapering anteriorly, rounded in front, occupies about 2/3rd the length of head shield, three pairs of lateral glabellar furrows prominent, anterior pair short and faint, posterior pair longer and well developed; axial furrows deep; palpebral ridges well marked and start obliquely outward from the base of the anterior pair of glabellar furrows, palpebral lobes of medium size and situated opposite the mid-length of glabella; palpebral area of fixigene about 0.6 the width of glabella at middle; occipital furrow shallow, moderately arched backward, occipital ring wider in the middle, sub-triangular in outline and bears a small node at the posterior end; anterior border swollen, wider at middle and narrowing toward the lateral sides, a median boss present at the anterior border, outer margin of the anterior border gives a sub-conical appearance; the ratio of prelabellar field and median width of anterior border about 1:1.5; anterior course of facial suture diverge moderately in-

ward and down to the palpebral lobes and after curving around the eyes extend obliquely outward to the postero-lateral extremities of the cranidium.

Dimensions (in mm) :

	KUF 692a	KUF 693c
Cranidium (Holotype)		
Length of cranidium	8.5	4.5
Width at palpebral lobes	7.0	3.5
Length of glabella	5.5	3.0
Width of glabella at base	3.0	1.5
Preglabellar field	1.2	0.6
Length of anterior border at middle	1.8	0.9

Remarks : The specimens are similar to *Anomocaraspis perfucta* in the overall outline of cranidium, glabellar detail, size and position of palpebral lobes and in the subtriangular shape of anterior border but differ from it in the presence of a well marked median boss on the anterior border and in the sub-triangular neck ring with a small node at the posterior end.

Horizon and locality : The specimens were collected from the Kandi (Tarus) - Nutunus section from Tonkinella - Anomocaraspis Zone.

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EXPLANATION OF PLATE**Plate I**

Anomocaraspis hundwarensis (Reed)

2. Cranidium x 9.2
5. Complete Exoskeleton x 6.4

Anomocaraspis perfuncta (Reed)

1. Cranidium x 6.6
3. Cranidium x 5.2
7. Cranidium x 5.8
11. Cranidia (Two) x 5.5
12. Cranidium x 6.4

Anomocaraspis kupwarensis n.sp.

6. Cranidium x 6.2
8. Cranidium x 6.8
9. Cranidium (Holotype) x 6.3

Anomocaraspis globosa n.sp.

4. Cranidium (Holotype) x 6.4
10. Cranidium x 6.0

