

## CAMBRIAN FAUNAS OF CHINA.<sup>a</sup>

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### INTRODUCTION.

In the first paper on the Cambrian Faunas of China<sup>b</sup> a historical introduction was given along with a list of the species known at the date of the publication of the paper.

During the summer of 1905 a box of fossils, that had been lost, was received in Washington. This material was collected by Mr. Eliot Blackwelder under the direction of Mr. Bailey Willis, principally from the provinces of Shen-si and Shan-si. It has afforded a number of new species, but has not added otherwise materially to our knowledge of the Cambrian faunas of China except in the case of the occurrence of the genus *Coscinoocyathus*.

The illustrations for the report on the Cambrian faunas of China, collected by Messrs. Willis and Blackwelder, are now well advanced, and it is anticipated that the full report, including descriptions of genera and species and paleontological correlations and illustrations, will be published before the close of 1906.

When preparing the preliminary notes on the Cambrian faunas of China<sup>b</sup> in 1905, I had not noticed that H. Monke had published a paper on the Geology of Shan-tung, and described certain "Upper" Cambrian trilobites.<sup>c</sup> It was not until February 27, 1906, that the Jahrbuch containing the paper arrived at the United States Geological Survey library.

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<sup>a</sup> Preliminary Paper No. 2.

<sup>b</sup> Proc. U. S. Nat. Mus., XXIX, Sept., 1905, pp. 1-106.

<sup>c</sup> Beiträge zur Geologie von Schantung. I. Obercambrische Trilobiten von Yentsy-yai. Jahrb. d. K. P. Geol. Landesanst. und Bergakad. zu Berlin, XXIII, Pt. 1, 1903, pp. 103-151.

The following is a list of the genera and species described by H. Monke:

- |                                 |                                      |
|---------------------------------|--------------------------------------|
| 1. <i>Agnostus koerferi</i> .   | 5. <i>Drepanura premesnili</i> .     |
| 2. <i>Liostracina krausei</i> . | 6. <i>Drepanura ketteleri</i> .      |
| 3. <i>Teinistion lansi</i> .    | 7. <i>Stephanocare richthofeni</i> . |
| 4. <i>Teinistion sodeni</i> .   | 8. <i>Stephanocare</i> sp.           |

Of the above three genera and species described by me in 1905 are synonyms:

*Liostracina krausei* Monke = *Ptychoparia ceus* Walcott.

*Teinistion lansi* Monke = *Dorypygella typicalis* Walcott.

*Stephanocare richthofeni* Monke = *Damesella chione* Walcott.

The following are new forms:

*Drepanura ketteleri* Monke.

*Teinistion sodeni* Monke.

I do not find that *Agnostus koerferi* Monke differs specifically from *Agnostus chinensis* Dames.

*Teinistion lansi* Monke is similar in many respects to *Shantungia spinifera* Walcott, but differs in the presence of an incurved frontal margin, and the absence of the long frontal spine.

The detailed sections worked and the succession of the contained faunas show that the horizon of the fauna described by Monke is the upper part of the Middle Cambrian, and not Upper Cambrian as determined by Monke. The detailed sections and lists of faunas will be given in the paleontological report.

#### ASSOCIATION OF GENERA AND SPECIES.

In order that the student may be saved the labor of making lists of the species from the various localities, the following lists are inserted. The species given in each list do not all occur in the same layer of rock, but they are from the same band of layers: The number of layers and their thickness will be given in Mr. Blackwelder's report on the detailed sections. The stratigraphic range is limited so as to avoid the commingling of faunas from distinct faunal zones.

The line between the Middle and Upper Cambrian faunas is placed at the top of the Ku-shan shale. The fauna of the Ku-shan shale includes species of *Damesella*, *Dorypyge*, and genera that are typical of the Middle Cambrian fauna, while the fauna of the Ch'au-mi-tien limestone, above the Ku-shan shale, is more nearly related to that of the Upper Cambrian of North America and northwestern Europe.

The line of the Lower Cambrian is placed at the top of the Man-t'o formation, as the predominant trilobite, *Redlichia*, is more closely

related to *Olenellus* than to the trilobites of the Middle Cambrian fauna.

Upper Cambrian...Ch'an-mi-tien formation.....	Brachiopoda: <i>Discinopsis sulcatus</i> . Trilobita: <i>Anomocare</i> , species undetermined. <i>Anomocarella irma</i> . <i>Ptychaspis bella</i> .
Middle Cambrian, Ku-shan formation.....	Trilobita: <i>Blackwelderia citiz</i> Walcott. <i>Agraulos regularis</i> . Anthozoa: <i>Coscinocyathus elvira</i> . Brachiopoda: <i>Obolus (Lingulepis?)</i> , species undetermined. <i>Yorkia? orientalis</i> . <i>Orthis (Plectorthis) agreste</i> , <i>O. (P.) kichouensis</i> , <i>O. (P.)</i> , species undetermined. Gastropoda: <i>Secnella? dilatatus</i> . <i>Platyceras willisi</i> . <i>Stenotheca?? simplex</i> . Trilobita: <i>Dorypyge richthofeni levis</i> .
Middle Cambrian, Ch'ang-hia (Ki-chóu) formation.....	<i>Agraulos armatus</i> , <i>A. nitida</i> , <i>A. obscura</i> , <i>A. uta</i> , <i>A. vicina</i> . <i>Agraulos (?) a capax</i> , <i>A. (?) melic</i> . <i>Anomocare bigsbyi</i> , <i>A. eriopia</i> , <i>A. flava</i> . <i>Anomocarella contigua</i> . <i>Ptychoparia comus</i> , <i>P. inflata</i> , <i>P. lilia</i> , <i>P. nercis</i> , <i>P. undata</i> , <i>P. vesta</i> , <i>P.</i> , species undetermined. <i>Ptychoparia (?) maia</i> . <i>Ptychoparia (Liostracus) intermedia</i> , <i>P. (L.) subrugosa</i> . <i>Solenopleura pauperata</i> . <i>Dolichometopus hyrie</i> .

α Interrogation points within parentheses indicate undetermined subgenera.

TABLE SHOWING GEOLOGIC AND GEOGRAPHIC DISTRIBUTION OF THE FAUNA.

	Horizons.			Localities.								
	L.	M.	U.	Near Wu-t'ai-hiën.	Near T'ai-an-fu.	Near Fang-lan-chón.	Near Tung-yü-chón.	Yaó-to, near Wu-t'ai-hiën.	Ch'ang-hia.	Near Yen-chuang.	Ch'an-mi-tien.	
ANTHOZOA.												
<i>Coscinocyathus elvira</i> , new species.....		×		×								
BRACHIOPODA.												
<i>Obolus (Lingulepis?)</i> , species undetermined.....		×				×						
<i>Discinopsis sulcatus</i> , new species.....		×	×		×							
<i>Yorkia? orientalis</i> , new species.....		×					×					
<i>Orthis (Plectorthis) agreste</i> , new species.....		×								×		
<i>Orthis (Plectorthis) kichouensis</i> , new species.....		×										
<i>Orthis (Plectorthis)</i> , species undetermined.....		×			×		×		×			

TABLE SHOWING GEOLOGIC AND GEOGRAPHIC DISTRIBUTION OF THE FAUNA—Cont'd.

	Horizons.			Localities.							
	Cambrian.			Near Wu-fai-hiën.	Near T'ai-an-fu.	Near Fung-lan-chön.	Near Tung-yü-chön.	Yü-tö, near Wu-fai-hiën.	Chang-hia.	Near Yen-chuang.	Ch'au-an-tien.
	L.	M.	U.								
GASTROPODA.											
<i>Scenella? dilatatus</i> , new species.....		x				x	x				
<i>Platyceras willisi</i> , new species.....		x				x					
<i>Stenotheca?? simplex</i> , new species.....		x					x				
TRILOBITA.											
<i>Dorypyge richthofeni levis</i> , new variety.....		x				x	x				
<i>Blackwelderia cilie</i> Walcott.....		x				x					
<i>Agraulos armatus</i> , new species.....		x									
<i>nitida</i> , new species.....		x		x							
<i>obscura</i> , new species.....		x				x					
<i>regularis</i> , new species.....		x				x					
<i>ula</i> , new species.....		x		x							
<i>vicina</i> , new species.....		x					x				
<i>Agraulos (?) capax</i> , new species.....		x					x				
(?) <i>metie</i> , new species.....		x		x			x				
<i>Anomocare bigsbyi</i> , new species.....		x					x				
<i>criopta</i> , new species.....		x						x			
<i>flava</i> , new species.....		x				x					
species undetermined.....			x					x			
<i>Anomocarella configua</i> , new species.....		x								x	
<i>irma</i> , new species.....			x					x			
<i>Ptychaspis tella</i> , new species.....			x			x					
<i>Ptychoparia comus</i> , new species.....		x					x				
<i>inflata</i> , new species.....		x				x					
<i>lilla</i> , new species.....		x		x							
<i>nercis</i> , new species.....		x				x					
<i>undata</i> , new species.....		x					x				
<i>vesta</i> , new species.....		x				x					
species undetermined.....		x					x				
<i>Ptychoparia (?) maina</i> , new species.....		x					x				
<i>Ptychoparia (Liostracus) intermedia</i> , new species.....		x									x
<i>Ptychoparia (Liostracus) subrugosa</i> , new species.....		x								x	x
<i>Solenopleura pauperata</i> , new species.....		x									
<i>species</i> .....		x					x				
<i>Dolichometopus hyrie</i> , new species.....		x				x					

## ANTHOZOA.

## Genus COSCINOCYATHUS Bornemann.

*Coscinocyathus* BORNEMANN, 1884, Deutsch. geol. Gesell., Zeitsch. XXXVI, p. 704.

## COSCINOCYATHUS ELVIRA, new species.

This species is represented by one small cup, a fragment of the interior wall of a larger cup, and a thin section showing a portion of the wall and the diagonally transverse section near the base of the cup. The cup has a height of 3 mm., and a diameter of 3 mm. at the aper-

ture. The exterior surface appears smooth under a lens of moderate power, but with a strong lens it is found to be perforated by minute pores; the interior surface is marked by arching ridges, radiating from the base toward the outer edge, connected by transverse ridges, between which rounded pits occur. A diagonally transverse thin section shows the system of ridges described and the openings between them. The same section cuts across near the base of a cup. In this the calcite is so crystallized that no definite structure, with the exception of a few traces of septa extending from the inner wall to the outer wall, can be distinguished.

The fragment illustrating the interior wall indicates a cup that expanded much more rapidly than the cup described above. It may be that a second species is indicated by this, but with the material available for study it does not appear best to attempt to distinguish them by applying distinct names.

When the surface of the outer wall is slightly worn the radiating lines and transverse septa are very clearly shown.

*Observations.*—The generic reference to *Coscinoocyathus* is made on account of the presence of the regular cross septa in addition to the radial septa, as defined by Dr. J. G. Bornemann.<sup>a</sup> None of the Siberian forms of the *Archæocyathinæ* described by Dr. Eduard von Toll<sup>b</sup> appears to be closely related to this species.

The specific name is given in recognition of the work of Miss Elvira Wood in the preliminary study of the Cambrian fauna of China.

*Formation and locality.*—Middle Cambrian, in a brownish gray, partly oolitic limestone, in a horizon corresponding to the lower portion of the Ch'ang-hia formation of Shan-tung; 4.5 miles south of Wu-t'ai-hiën, Shan-si, China.

Collected by Eliot Blackwelder.

## BRACHIOPODA.

Genus OBOLUS Eichwald.

LINGULEPIS Hall, subgenus of OBOLUS.

OBOLUS (LINGULEPIS?), species undetermined.

This species is represented by a few fragments, one of which shows that the ventral valve is elongate, and the apex acuminate. The shell was built up of several layers or lamellæ, as in characteristic forms of *Obolus* and its subgenera. The interior surface of some of the lamellæ is marked by fine, radiating, and concentric striæ; the outer surface, under a strong magnifier, shows fine, concentric, somewhat irregular striæ.

<sup>a</sup>Deutsch. geol. Gesell. Zeitsch., XXXVI, 1884, p. 704.

<sup>b</sup>Mém. de l'Acad. Imp. des Sciences de St.-Pétersb., 8th ser., VIII, No. 10, 1899.

*Formation and locality.*—Middle Cambrian, lower portion of oolitic limestone series; 4 miles east of Fang-lan-chôn, Shan-si, China.

Collected by Eliot Blackwelder.

Genus DISCINOPSIS Matthew.

*Acrotreta?* MATTHEW, 1885, Illustrations of the Fauna of the St. John Group, No. 6, p. 37.

*Discinopsis* (MATTHEW MS.) HALL and CLARKE, 1892, Pal. New York, VIII, Pt. 1, pp. 105, 167.

The original diagnosis of the genus is as follows:

“*Diagnosis.*—Shell subcircular in outline. Surface depressed-conical, apices excentric, not marginal. Pedicle-valve with the apex truncated by a circular foraminal aperture(?). The interior of this valve is characterized by a pair of deep, diverging furrows, passing forward from the beak or internal foraminal opening, in broad curves which converge toward the anterior margin but without meeting. These furrows enclose a thickened and somewhat elevated central area, which, in the subumbonal region is apparently free, projecting for a short distance, like a narrow, triangular shelf, beneath which the foramen probably opened. The interior opening of the foramen is, however, not apparent on any of the specimens examined, for, as usually preserved, the matrix has adhered to this subapical cavity, and in a single example only, is the shelf-like character of the median area distinctly demonstrated. A faint longitudinal ridge passes from the apex of the shelf to the anterior margin, but no other markings are discernible on the interior except faint radiating or slightly undulating, probably vascular lines.

“The interior of the brachial valve, as far as known, shows no other characters than the radiating lines, which appear to belong to the ornamentation of the outer surface.

“Shell-substance tenuous, apparently corneous. External surface covered with more or less prominent, sometimes lamellose concentric growth-lines, crossed by fine, gently curved, radiating striae which are usually more prominent when the concentric lines are exfoliated.

“Type, *Discinopsis guielmi* Matthew.”

DISCINOPSIS SULCATUS, new species.

*Craniella?* sp. WALCOTT, 1905, Proc. U. S. Nat. Mus., XXIX, pp. 4, 6.

This species is based upon the cast of the interior of a small ventral valve, that in its interior markings closely approaches the interior of the ventral valve of *Discinopsis guielmi* Matthew.<sup>a</sup>

The interior cast shows that the ventral valve was subcircular in outline, moderately convex, and with the apex probably perforated

<sup>a</sup> Illustrations of the Fauna of the St. John Group, 1885, No. 6, p. 37.

by a small, circular foraminal aperture. In front of the cast of the base of the foraminal aperture there is a broad depression that extends to the front margin; on each side of the central depression an elongate, slightly depressed area extends forward and outward from near the base of the cast of the foraminal aperture, along the ridge on each side of the median depression; back of the base of the foraminal aperture there is a narrow, short, arched furrow that indicates the presence of a corresponding ridge on the interior of the shell. No other markings are shown on the cast, except the faint outline of what may have been the visceral area, on the median line in front of the base of the foraminal aperture and between the broad vascular sinuses.

*Observations.*—This species is referred to the genus *Discinopsis* as the result of comparison with specimens of the interior of a ventral valve of *D. guilelmi*. One interior of the latter species has scars much like those in *D. sulcatus*.

*Formation and locality.*—Upper Cambrian, upper part of Ch'au-tien limestone; Pagoda Hill, 1 mile west-southwest of Tai-an-fu, Shan-tung, China.

Collected by Eliot Blackwelder.

#### Genus YORKIA Walcott.

*Yorkia* WALCOTT, 1897, Proc. U. S. Nat. Mus., XIX, p. 714.

#### YORKIA? ORIENTALIS, new species.

This species is represented by a single small ventral valve, which has the external characteristics of *Yorkia wanneri*, of the Lower Cambrian.<sup>a</sup> The outline of the valve is transversely and broadly oval in outline, exclusive of the apex rising above the posterior margin; the apex gives a subtriangular outline to the valve when looking down upon it; the apex is moderately elevated, and projects over the posterior margin; it is perforated by a rather large aperture just above a small false area.

The surface of the valve is marked by low, rather broad, concentric undulations, a few fine, concentric striae, and a very finely reticulate ornamentation, formed by the crossing of oblique, elevated, curved lines, which form slightly elongate, diamond-shaped pits between them. Shell substance apparently calcareous. Width of ventral valve, 2.5 mm.; length, 2 mm. at aperture, 2.25 mm. at apex; elevation, 0.5 to 0.75 mm.

*Observations.*—As far as may be determined by the exterior of the valve this species is properly referred to *Yorkia*. The generic reference, however, will remain in doubt until information is available as to the characters of the interior of the valve.

<sup>a</sup>Proc. U. S. Nat. Mus., XIX, 1897, p. 715, pl. LX, fig. 1.

*Formation and locality.*—Middle Cambrian, central portion of Ki-ch'ou formation, in a dark gray limestone; 4 miles south-southwest of Tung-yü-ch'ou, Shen-si, China.

Collected by Eliot Blackwelder.

Genus ORTHIS Dalman.

PLECTORTHIS Hall and Clarke, subgenus of ORTHIS.

ORTHIS (PLECTORTHIS) AGRESTE, new species.

Shell transverse, subsemicircular; a ventral valve 9 mm. in length has a width of 12 mm., and a hinge line 10.5 mm. in length; ventral valve moderately and regularly convex, with the apex curved down to an area that is slightly inclined backward from the hinge line; the details of the cardinal area are unknown.

Surface marked by rounded, radiating ribs and interspaces, 6 ribs in a space of 3 mm. near the front margin; a few of the ribs bifurcate, but most of them extend from the umbo to the front margin; the ribs are crossed by fine, concentric striae and strong lines of growth.

*Observations.*—This shell is characterized by its regular convexity and the uniformity of the rounded, radiating ribs.

*Formation and locality.*—Middle Cambrian, near base of the Ch'ang-hia formation in dirty gray, fossiliferous limestone; 1 mile east-south-east of Ch'ang-hia, Shan-tung, China.

Collected by Eliot Blackwelder.

ORTHIS (PLECTORTHIS) KICHOUENSIS, new species.

This species is represented by a specimen of the dorsal valve. The outline of the shell is transversely rounded subquadrilateral; length, 9 mm.; width, 13 mm.; the highest point above the plane of the margin is about 3 mm. above the hinge line; a shallow median sinus begins at the umbo, and gradually widens toward the front margin; back of the umbo the shell extends beyond the hinge line, and then recedes to the beak, which apparently is at or a little over the upper edge of a very narrow area.

Surface marked by numerous radiating, rounded ribs, with narrow interspaces, 7 ribs in a distance of 5 mm.; a few bifurcations of the ribs occur at irregular intervals between the apex and the margins. There are no traces of concentric striae; if on the shell originally, they have been removed by the wearing off of the outer surface.

*Observations.*—This species is distinguished from all other species by the strong, incurved umbo, and rounded ribs with narrow interspaces.

*Formation and locality.*—Middle Cambrian, in lower part of Ki-ch'ou formation, in brown-gray, oolitic limestone; 4.5 miles south of Wu-t'ai-hien, Shan-si, China.

Collected by Eliot Blackwelder.



## ORTHIS (PLECTORTHIS), species undetermined.

This species is represented by a single specimen of the ventral valve. Ventral valve convex, with the apex curving gently downward from the highest point to the cardinal area; transverse; length, 2.5 mm.; width, 3 mm.; hinge line a little shorter than the greatest width; cardinal area sloping slightly backward from the hinge line.

Surface marked by about 16 strong, nearly regular, rounded, radiating ribs, that are crossed by fine, concentric striae, lines of growth, and one strong ridge indicating interruption of growth.

*Observations.*—This little shell was at first placed with *Orthis* (*Plectorthis*) *agreste* (p. 570), but further study showed that its greater convexity, elevated apex, and stronger ribs distinguished it from that species.

*Formation and locality.*—Middle Cambrian, upper portion of Ch'ang-hia formation, near top of dark, oolitic limestone series; 2 miles north-northeast of Ch'ang-hia, Shan-tung, China.

A larger shell of this type occurs in Shen-si, in the central portion of the Ki-ch'ou formation. It has a length of 6.5 mm., and a width of 7.5 mm. The surface is marked by numerous radiating ribs, similar to those of the shell from Ch'ang-hia, also concentric striae and several ridges resulting from interruption of growth.

The locality is 4 miles south-southwest of Tung-yü-ch'ou, Shen-si, China.

A third shell, that appears to be a dorsal valve, was found in limestone pebbles in river gravel. The surface is partially exfoliated, but it shows rounded, radiating ribs and concentric ridges, similar to those on the two specimens described above.

The associated fragments of trilobites suggest the Middle Cambrian fauna.

The locality is in the railroad grade, one-third mile west of west city gate, Tai-an-fu, Shan-tung, China.

Collected by Eliot Blackwelder.

## GASTROPODA.

Genus SCENELLA Billings.

SCENELLA? DILATATUS, new species.

This species is based upon two specimens which preserve the expanded outer margin, but not the elevated, central, conical portion of the shell. The exterior outline is oval, the length of the type specimen being 9 mm.; width, 7 mm. The surface on the inner side of the campanulate margin is marked by numerous radiating, elevated striae. As viewed from the lower side the margin slopes gently inward to a shallow depression, or furrow, within which there is a rounded, slightly ele-

yated ridge, that extends around the border of the elevated portion of the shell, except on what is supposed to be the posterior side; on this side the curvature from the margin across the border to the elevated portion of the shell is uninterrupted.

A second specimen occurs in the collection which shows the exterior surface. This is smooth, and corresponds in surface configuration approximately to the reverse of the specimen above described. Unfortunately it is in a very fragmentary state, neither the outline of the margin nor the central, elevated portion being preserved.

*Observations.*—This species is distinguished by the broad, campanulate-like border; it differs from *Secuella clotho* Walcott<sup>a</sup> in its smooth, exterior surface, and the strong, radiating striae on the inner surface, both the outside and inside of the shell of *S. clotho* being marked by concentric striae and lines of growth.

*Formation and locality.*—Middle Cambrian, lower portion of Kichou formation, in a brown, oolitic limestone; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

Genus PLATYCERAS Conrad.

PLATYCERAS WILLISI, new species.

Shell minute, consisting of two whorls somewhat irregularly incurved; the apex and one side of the aperture lie in the same plane; the outer whorl increases in size gradually through its first half, and then expands more rapidly toward the aperture; a cross section of the outer whorl shows the dorsal (outer) side to be gently convex, and the inner side somewhat more strongly convex, a rounded dorsal angle being formed where the two sides unite on the outer edge.

The surface is marked by concentric lines of growth parallel to the aperture.

The greatest diameter of the largest shell is 1.6 mm.

*Observations.*—This species differs from *Platyceras chronus* Walcott<sup>b</sup> in having a more slender, rounded, outer whorl, without trace of the dorsal ridge characteristic of that species. It differs from *P. clytia* Walcott<sup>b</sup> in being coiled on the plane of the dorsal side instead of on the plane of the median line.

*Formation and locality.*—Middle Cambrian, in greenish gray limestone, interbedded in argillaceous shales; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 12.

<sup>b</sup>Idem, p. 14.

## Genus STENOTHECA Salter.

## STENOTHECA ?? SIMPLEX, new species.

Shell small, depressed conical, with the apex situated about one-sixth the distance from the front to the posterior margin; the point of the apex is broken away; aperture subcircular, and little broader than long.

Surface concentrically striated, with a trace of a shallow furrow extending from the apex toward the central portion of the anterior margin.

The greatest diameter of the type and only specimen is 2 mm.

*Observations.*—This species differs widely from other known species from China. It may be compared with some varieties of the young of *Stenotheca rugosa*, but it differs in the aperture being broader, and not having a rugose surface. The continuous concentric striae and absence of any indication of an area show that it is a gasteropod, but its generic reference is doubtful.

*Formation and locality.*—Middle Cambrian, lower portion of Ki-chón formation, in a brown, oolitic limestone; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

## TRILOBITA.

## Genus DORYPYGE Dames.

## DORYPYGE RICHTHOFENI LÆVIS, new variety.

This variety is characterized by a nearly smooth surface. An associated pygidium and heads of *D. richthofeni* Dames<sup>a</sup> have tubercles over most of the surface.

*Formation and locality.*—Middle Cambrian; 4 miles east of Fung-lan-chön, Shan-si; and 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

## Genus BLACKWELDERIA, new genus.

*Genotype.*—*Blackwelderia sinensis* Bergeron.<sup>b</sup>

## BLACKWELDERIA CILIX Walcott.

*Olenoides ? cilix* WALCOTT, 1905, Proc. U. S. Nat. Mus., XXIX, p. 27.

This species is represented by numerous specimens of the central portions of the head, separated free cheeks, and associated specimens

<sup>a</sup> China, Richthofen, IV, 1883, p. 24.

<sup>b</sup> *Calymene ? sinensis* BERGERON, 1899, Bull. de la Soc. Géol. de France, 3d ser., XXVII, p. 500.

of the pygidium. These indicate that the general form of the head was transversely semicircular, and rather strongly convex, and that the margin of the head was of medium width in front, gradually widening to the free cheek, where it narrows toward the base of the postero-lateral spine. A postero-lateral spine projects backward and slightly upward from a point on the margin a little in advance of the postero-lateral angle. Glabella truncato-conical in outline, and marked by three pairs of furrows, the posterior of which extends obliquely backward nearly to the occipital furrow; the anterior furrows are indicated by short, slight depressions on the edges of the glabella next to the dorsal furrow; they are situated so as to divide the space between the posterior furrows and the front margin of the glabella into subequal spaces; a very narrow, slightly indicated, median, longitudinal ridge extends from the occipital furrow nearly to the front of the glabella; occipital furrow strongly marked, rounded, and about as wide as the occipital segment; occipital segment of medium width, convex, and arching forward slightly at the center; a shallow furrow crosses it on each side so as to outline a rounded node at each end; dorsal furrow rounded, rather strong at the ends, and merging into the broad concave slope of the frontal limb.

Fixed cheeks about one-half the width of the glabella; they rise abruptly from the dorsal furrow to the base of the palpebral lobes, and slope rapidly from the palpebral lobes backward to the posterior furrow, and more rapidly to the front, where they merge into the concave frontal limb; palpebral lobes small, elevated, separated from the fixed cheeks by a shallow furrow, and situated opposite the central part of the head; ocular ridges indicated by depressed lines that extend from the anterior end of the palpebral lobes, across the fixed cheeks, to the dorsal furrow; postero-lateral limb about one-third the width of the head within the facial sutures; it is marked by a broad, shallow furrow within the narrow posterior margin; frontal limb broad, concave, and rising with a gentle curvature from the front of the glabella to the margin of the thickened frontal rim.

Free cheek roughly subtriangular; it is divided into an interior, convex body, which rises from the furrow at its base to the small eye lobe at its center; the border of the head is crossed obliquely by a sharp ridge that extends from its inner, anterior side, backward to its outer side, where it forms the outer edge of a sharp spine; the border extends backward to the postero-lateral angle of the cheek, and inward to the facial suture; a strong spine originates a little in advance of the postero-lateral angle and extends obliquely backward.

The associated pygidium is subsemicircular; axial lobe strong, and tapering gently from the front toward its rounded termination; it is divided by five well defined, deep transverse furrows, that cross it from side to side, and a sixth posterior furrow that crosses only its

upper portion; the furrows divide the axis into five segments, or rings, and the subtriangular terminal portion, that slopes rapidly from its center to the thickened border; lateral lobes broad, convex, and marked by a narrow, anterior, elevated segment, which joins the thorax, and three strong, narrow, elevated ridges, and a small node terminating a fourth ridge; the ridges are separated by broad, strong furrows that are continuations of the furrows crossing the axis; the thickened border is separated from the body of the pygidium by a shallow groove; from the border there are backward extending spines on each side of the central axis, the second of which, on each side of the axis, is longer and stronger than the others.

Surface of the crust of the head, free cheeks, and pygidium, and associated fragments of the segments of the thorax minutely punctate. The largest head in the collection has a length of 20 mm., with the same width at the palpebral lobes; the largest pygidium has a width of 35 mm. and a length of 18 mm., exclusive of the spines.

*Observations.*—The character of the frontal limb and rim of this species is quite like that of the type of the genus, *Blackwelderia sinensis* Bergeron.<sup>a</sup> There is a difference in the surface, as there are no tubercles known on the surface of *B. cilix*.<sup>b</sup> On account of the general resemblance between the heads and pygidia of the genera *Damesella* and *Blackwelderia* we may compare species of the two genera. We find in *B. sinensis* Bergeron a form of head and surface somewhat intermediate between *Damesella blackwelderi*<sup>c</sup> and *B. cilix*. The surface of *B. sinensis* is minutely punctate like that of *B. cilix*, and in addition it has scattered pustules of the character of those so thickly dispersed over the surface of *D. blackwelderi*. The frontal limb of *B. sinensis* is somewhat intermediate in form between that of *B. cilix* and *D. blackwelderi*. If the border of *B. sinensis* were a little more thickened we should have the appearance of the frontal rim or border of *D. blackwelderi*. One of the specimens of *B. sinensis* has a frontal limb and border somewhat like that of *B. cilix*.

The form of the glabella of *B. cilix* is similar to that of *B. sinensis* Bergeron, but the frontal limb is much broader than in that species, the fixed cheeks narrower and less elevated, and the surface is apparently without granulations.

*Formation and locality.*—Middle Cambrian, in a concretionary, ocherous limestone that may correspond to the Ku-shan shale horizon of the Shan-tung sections; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

<sup>a</sup> *Calymene? sinensis* BERGERON, 1899, Bull. de la Soc. Géol. de France, 3rd ser., XXVII, p. 500.

<sup>b</sup> *Olenoides? cilix* WALCOTT, 1905, Proc. U. S. Nat. Mus., XXIX, p. 27.

<sup>c</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 35.

## Genus AGRAULOS Corda.

## AGRAULOS ARMATUS, new species.

This species is represented by a finely preserved specimen of the central portions of the head, exclusive of the free cheeks. The glabella is strongly convex, with the sides slightly converging toward the rounded front; it is marked by three pairs of short, obscure glabellar furrows close to the dorsal furrow; the occipital furrow is indicated by a short, scarcely discernible depression toward the side of the union of the glabella and occipital ring; occipital ring a little narrower than the glabella and extended backward into an extraordinarily strong spine, that is nearly as broad as the glabella to a point corresponding in length with the glabella; the posterior termination of the spine is not preserved; on the side view the surface of the glabella extends backward continuously with that of the occipital ring and spine, on the same plane; the strong backward extension of the glabella recalls some of the large occipital spines in some species of *Microdiscus*; dorsal furrow deep, and strongly developed on the sides and in front of the glabella.

Fixed cheeks about as wide as the glabella, strongly convex, and merging into a convex frontal limb that is wider and more convex than the fixed cheeks; palpebral lobes small; a narrow, clearly defined ocular ridge extends obliquely backward across the fixed cheek from the antero-lateral angle of the glabella.

Surface minutely granular under a very strong lens. The type specimen has a length of 5 mm., exclusive of the combined occipital ring and spine.

*Observations.*—This species is most nearly related to *A. (?) melie* (p. 581) and *A. acalle* Walcott.<sup>a</sup> It differs from them in the form of the convex fixed cheeks and frontal limb, the presence of ocular ridges, the extraordinarily strong occipital spine, and in having a proportionately shorter glabella.

*Formation and locality.*—Middle Cambrian, in brownish gray, oolitic limestone, 10 feet above red shales of supposed Man-t'o formation age; 4.5 miles south of Wu-t'ai-hiën, Shan-si, China.

Collected by Eliot Blackwelder.

## AGRAULOS NITIDA, new species.

This species is represented by the central portions of the head, exclusive of the free cheeks; the front within the facial sutures is strongly rounded, indicating a semicircular outline for the head, which was moderately convex. Glabella truncato-conical, moderately convex, and not very clearly defined from the fixed cheeks and frontal limb; there are no traces of glabellar furrows; occipital furrow repre-

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 43.

sented by a slight depression at the base of the glabella; occipital ring very narrow at the sides, thickening rapidly toward the center so as to give it a subtriangular outline, the apex of which terminates in a small spine of unknown length; dorsal furrow indicated by the difference in slope of the glabella and fixed cheeks and frontal limb.

Fixed cheeks less than one-half the width of the glabella, nearly flat opposite the palpebral lobes, and sloping gently downward to the posterior furrow, and to the front to merge into the frontal limb, which is slightly convex; palpebral lobes about one-fourth the length of the head.

Surface slightly roughened by what appears to be a minutely granulated surface as shown by a strong lens.

The largest head in the collection has a length of 5 mm.

*Observations.*—This species is most nearly related to *Agraulos dolon* Walcott.<sup>a</sup> The head of the latter differs in being longer in proportion to the width, and in having broader fixed cheeks.

*Formation and locality.*—Middle Cambrian, in brownish-gray, colitic limestone, 10 feet above red shales of supposed Man-t'o formation age; 4.5 miles south of Wu-t'ai-hiën, Shan-si, China.

Collected by Eliot Blackwelder.

AGRAULOS OBSCURA, new species.

This species is represented by the central portions of the head, exclusive of the free cheeks. The glabella and fixed cheeks moderately convex; glabella truncato-conical, with the front margin gently curved, and antero-lateral angles slightly rounded; the postero-lateral angles are more broadly rounded and pass into the line of the posterior margin of the occipital ring without interruption by the occipital furrow; surface of glabella smooth, with the exception of some very slight indications of a posterior pair of furrows; occipital furrow shallow, and dying out before reaching the dorsal furrow; occipital ring narrow at the ends, broadening and rising toward the center to form the base of what may be a short spine, or a slight upward projection of the central portion of the posterior margin of the ring; dorsal furrow of medium width and well defined at the sides and front of the glabella.

Fixed cheeks narrow, convex, rising into narrow ridges that anteriorly form a node or swelling where they merge into the frontal limb, posteriorly they slope down to merge with the postero-lateral limb; palpebral lobes small, somewhat elevated, and separated from the fixed cheeks by a shallow furrow; there does not appear to be any ocular ridge; postero-lateral limb about as long as the width of the glabella in front; it is marked by a shallow furrow within the slightly rounded posterior margin; frontal limb and rim in front of the

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 45.

glabella moderately convex; on each side a broad, shallow furrow indicates that the dividing line between the frontal limb and rim was about half way between the front of the glabella and the frontal margin of the head.

Surface apparently smooth. The type specimen of the head is 7.5 mm. in length.

*Observations.*—This species indicates a type that is best represented by *Agraulos* (?) *melie* (p. 581). It differs from the latter in not having a swollen frontal limb, in the absence of ocular ridges, and in having a smaller, flat occipital ring. From *Agraulos divi* Walcott<sup>a</sup> this species differs in the presence of the side furrows delimiting the frontal limb and rim, narrower and more convex fixed cheeks, and less strongly marked occipital ring.

*Formation and locality.*—Middle Cambrian, lower portion of oolitic limestone series; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

#### AGRAULOS REGULARIS, new species.

This species is represented by a few specimens of the central portions of the head, exclusive of the free cheeks. These indicate that the head was rather strongly convex, and semicircular in outline. Glabella convex, truncato-conical, rounded in front, and with traces of two pairs of short glabellar furrows that divide it into three subequal portions; occipital furrow narrow but clearly defined; occipital ring narrow at the sides, increasing slightly in width toward the center where it rises to form the base of a small node; dorsal furrow deep and rather broad.

Fixed cheeks convex, rising abruptly from the dorsal furrow, the posterior furrow of the head, and from the anterior margin; in front they merge into the rounded, convex frontal limb with a trace of an intervening furrow and narrow ocular ridge; palpebral lobes small, and situated opposite the central portion of the glabella.

Surface, under a strong lens, shows traces of being very finely punctate. The average length of three specimens of the head is 2 mm.

*Observations.*—The head representing this species has the rounded, full fixed cheeks, and frontal limb of *Agraulos aculle* Walcott,<sup>b</sup> but it differs in having a proportionally shorter and broader glabella, and in being broader between the facial sutures.

*Formation and locality.*—Middle Cambrian, Ku-shan shale horizon of the Shan-tung section, in a fossiliferous, brownish-gray limestone; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

<sup>a</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 45.

<sup>b</sup> Idem, p. 43.



## AGRAULOS UTA, new species.

This species is based upon a single head, preserving the glabella and fixed cheeks, and frontal rim. It is of the same type as *Agraulos* (?) *capax* (p. 580), but differs in having a narrower fixed cheek, less convex and swollen frontal limb, and flatter frontal rim. The glabella is without traces of furrows, and the occipital ring is separated from it by a very shallow, scarcely noticeable transverse furrow; the frontal limb is rather broad and slightly swollen in front of the glabella; the general plane of the frontal limb and fixed cheeks is the same from a line drawn through the posterior end of the palpebral lobes.

Surface slightly roughened by a fine network of narrow, slightly elevated, inosculating lines. The type specimen has a length of 5.5 mm.

*Formation and locality.*—Middle Cambrian, Ki-chón limestone, in brown gray, partly oolitic bed, 10 feet above red shales supposed to correspond to the Man-t'o shales of the Shan-tung sections; 4.5 miles south of Wu-t'ai-hián, Shan-si, China.

Collected by Eliot Blackwelder.

## AGRAULOS VICINA, new species.

This species is represented by three specimens of the moderately convex central portions of the head, exclusive of the free cheeks. Glabella conical, convex, and without traces of glabellar furrows; occipital furrow transverse and clearly defined; occipital ring rather strong, transverse, and slightly convex; dorsal furrow rounded, of medium width, and clearly defined at the sides and front of the glabella.

Fixed cheeks about as wide as the glabella, moderately convex, and sloping forward and slightly downward into the frontal limb; palpebral lobes small, situated opposite the central portion of the glabella; ocular ridges narrow, slightly elevated, and extending from the anterior end of the palpebral lobe to a point corresponding to the antero-lateral angle of the glabella; postero-lateral limb short, and marked by a shallow furrow within its posterior margin; frontal limb short, convex in front of the glabella, arching slightly backward on each side to merge into the fixed cheeks; frontal rim broad, slightly convex, and separated by a shallow, slightly defined furrow at the angle formed by the union of the sloping frontal limb with the nearly flat frontal rim.

Surface roughened as seen by a high magnifying power. The largest specimen in the collection has a length of 3 mm.

*Observations.*—This species is characterized by its narrow, conical glabella, convex frontal limb that merges into the convexity of the fixed cheeks, and the presence of a distinct frontal rim. In the latter respect it approaches *Agraulos* (?) *capax* (p. 580), and *Agraulos uta*

(p. 579). It differs widely from *A. (?) capax* and less so from *A. uta* in its narrow, conical glabella, and the form of its frontal limb.

*Formation and locality.*—Middle Cambrian, in a brown, oolitic limestone, near the base of the Ki-chóu limestone, corresponding to the lower portion of the Ch'ang-hia limestone; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

AGRAULOS (?) CAPAX, new species.

As indicated by the central portions of the head, exclusive of the free cheeks, the head of this species is semicircular in outline, and moderately convex. The glabella narrows slightly from the base to its rounded front, which springs from the point where the ocular ridges pass into the dorsal furrow; the surface of the glabella is marked by three pairs of short, slightly impressed glabellar furrows that divide the glabella into a posterior, subtriangular lobe, two narrow lobes, and a larger, front terminal lobe; occipital furrow rounded, not very deep, and slightly wider at the sides than in the center; occipital ring narrow at the sides, widening toward the center where there is a low, small node near the posterior margin; dorsal furrow narrow, deep in front, and shallow at the sides of the glabella.

Fixed cheeks broad, rising gently from the dorsal furrow to the palpebral lobes; they slope gradually to the posterior furrow, and, in front of the ocular ridges, rather rapidly to the broad furrow defining the frontal limb; palpebral lobe small, narrow, and passing in front into a narrow ocular ridge, which crosses the fixed cheek to the anterolateral angle of the glabella; frontal limb separated from the glabella by a narrow, deep furrow, which widens out on each side; the limb is strongly convex immediately in front of the glabella, where it rises on some examples into a transverse boss; in other specimens it is not much higher than the general elevation of the glabella.

Surface finely punctate under a strong lens. The head of the largest specimen in the collection has a length of 7 mm., with a width of 12 mm. at the palpebral lobes.

*Observations.*—This species, at first sight, might be taken for a broad form of *Agraulos (?) melie* (p. 581), but on closer examination it is seen that the glabella is nearly rectangular instead of truncatoconical, the fixed cheeks are more than twice the width, and glabella narrower, in specimens of the same size. The ocular ridges of *A. (?) capax* are also unlike those of *A. (?) melie*.

*Formation and locality.*—Middle Cambrian, in a brown, oolitic limestone, near the base of the Ki-chóu limestone, corresponding to the lower portion of the Ch'ang-hia limestone; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

## AGRAULOS (?) MELIE, new species.

Central portions of head, exclusive of the free cheeks, convex. Glabella truncato-conical, convex, about one-half the length of the head, and marked by three pairs of short, faintly impressed glabellar furrows, and a narrow, median, longitudinal ridge; occipital furrow transverse, rounded, shallow, and fading out toward the center of the glabella; occipital segment narrow at the sides, widening rapidly to the central portion, which is as high as the glabella at the back, and sloping toward the occipital furrow at the base of the glabella; a minute node occurs at the center of the segment; dorsal furrow shallow, but strongly outlined.

Fixed cheeks narrow, elevated at the palpebral lobes, and sloping toward the glabella; a narrow ridge extends from the anterior, outer edge of the furrow on the inner side of the palpebral lobe to the furrow in front of the antero-lateral angle of the glabella, which corresponds to the ocular ridge; palpebral lobe long, narrow, and separated from the fixed cheek by a narrow furrow; frontal limb convex, rising to a prominent boss or swelling in front of the glabella, from which it is separated by a strong furrow; at the sides the frontal limb is narrow, and merged into the narrow fixed cheeks; postero-lateral limbs short, narrow, and separated from the fixed cheeks by a narrow, shallow furrow.

Surface finely punctate under a strong lens. The largest head in the collection has a length of 6 mm.

*Observations.*—This species is characterized by the tumid frontal limb, and the ridge within the palpebral lobe on the fixed cheek, a feature found on *Agraulos*, but not on any of the described forms from China.

*Formation and locality.*—Middle Cambrian, in a brownish gray limestone corresponding to the lower portion of the Ch'ang-hia limestone; 4 miles south-southwest of Tung-yü-chön, Shen-si, and 4.5 miles south of Wu-t'ai-hiën, Shan-si, China.

Collected by Eliot Blackwelder.

## Genus ANOMOCARE Angelin.

## ANOMOCARE BIGSBYI, new species.

Of this species only the central portions of the head, exclusive of the free cheeks, are known. Glabella moderately convex; a glabella 9 mm. in length has a width of 9 mm. at the base and 6 mm. in front; front rounded from the anterior side of the ocular ridges; surface marked by a pair of faintly impressed posterior furrows that extend obliquely backward from the dorsal furrow toward the center; a second pair of furrows is indicated by a smooth place on the surface; occipital furrow very shallow at the center, broader and slightly

deeper toward the sides, with a shallow pit near the dorsal furrow; occipital ring of medium width, very slightly convex; dorsal furrow shallow, but clearly indicated at the sides and front of the glabella.

Fixed cheeks narrow, flat opposite the palpebral lobes; they curve gently down toward the posterior furrow and more abruptly in front; palpebral lobes small, less than one-fifth the length of the head; the marginal rim is prominent, and passes obliquely into the low, broad ocular ridge which crosses the cheek obliquely to the antero-lateral angle of the glabella; frontal limb slightly concave, passing with very slight interruption into the flattened rim, the line of demarcation between the limb and rim being little more than the angle formed by the union of the sloping limb with the more nearly horizontal rim.

Surface minutely granular, the granules being irregularly distributed, and rising abruptly from the general surface. A head 15 mm. in length has the same width at the palpebral lobes.

*Observations.*—This species may be compared with *Anomocare temenus* Walcott,<sup>a</sup> *A. latelimbatum* Dames,<sup>b</sup> and *A. ? davis* Walcott.<sup>c</sup> From the first it differs in its broader glabella and less distinctly marked line between the frontal limb and rim; from the second it differs in a more rounded glabella, and narrower frontal limb; and from the third in having a more conical glabella and less concave frontal limb. The small palpebral lobe is like that of *Anomocare bergioni* Walcott.<sup>d</sup> It may be that the two species will be found to belong to another genus.

*Formation and locality.*—Middle Cambrian; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

#### ANOMOCARE ERIOPIA, new species.

The description of *Anomocare temenus* Walcott<sup>e</sup> covers the principal features of this species. *A. eriopia* differs in having a broader fixed cheek, less distinctly defined furrow between the frontal limb and frontal rim, and in the absence of a median ridge on the glabella. The associated pygidium differs from that of *A. temenus* in having a proportionately more convex axis, smaller pleural lobe, and in having the furrows on the pleural lobe extend nearly across the border of the pygidium. *A. eriopia* differs from *A. tatian* Walcott<sup>f</sup> in its broader frontal limb, and more depressed frontal limb and border, broader fixed cheeks, and less distinctly defined glabella.

<sup>a</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 53.

<sup>b</sup> China, Richthofen, IV, 1883, p. 14.

<sup>c</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 50.

<sup>d</sup> Idem, p. 47.    <sup>e</sup> Idem, p. 53.    <sup>f</sup> Idem, p. 53.

*Formation and locality.*—Middle Cambrian, near base of Ch'ang-hia formation in gray, oolitic series; Ch'ang-hia, Shan-tung, China.

Collected by Eliot Blackwelder.

**ANOMOCARE FLAVA**, new species.

Head, exclusive of the free cheeks, quadrilateral, and moderately convex. Glabella slightly convex in front, becoming more convex toward the center, along which there is a very slightly indicated longitudinal ridge. A glabella 6 mm. in length has a width of 5.5 mm. at the base and 4 mm. opposite the anterior edges of the ocular ridges, where the rounded front begins; the posterior pair of glabellar furrows is indicated on one specimen by a slight depression, on another, two pairs of furrows are indicated by slight scars about half way between the center and the sides of the glabella; occipital furrow shallow, scarcely more than indicating the line of division between the glabella and the occipital ring; the latter rises gently toward the center; dorsal furrow clearly indicated at the junction of the glabella and fixed cheeks, and also in front of the glabella.

Fixed cheeks about one-third the width of the glabella, nearly flat back of the ocular ridges, and sloping gently downward to merge into the frontal limb, and backward to the posterior margin of the head; ocular ridges low and rather broad, they terminate at the antero-lateral angles of the glabella from whence they extend obliquely backward to merge into the palpebral lobes; palpebral lobes little more than one-fourth the length of the head, and rather prominent; frontal limb in front of the glabella is about the same width as the frontal rim, it is slightly convex to the base of the rather abrupt posterior margin of the frontal rim.

The surface is marked by a few minute, scattered pores, to be seen only by a strong lens. The largest head has a length of 12 mm., with the same width at the palpebral lobes.

The associated pygidium has a broad, planulate margin, a narrow, convex axis, with six rings, indicated by shallow furrows, and a terminal segment; the furrows on the axis are extended out on the pleural lobes, disappearing on the planulate margin.

*Observations.*—The central portions of the head of this species differ from *Anomocare temenus* Walcott,<sup>a</sup> the nearest related form, in having a shorter glabella in proportion to its width, a tubercle or spine of unknown size on the occipital ring, and a smoother surface on the glabella. The associated pygidium is much like that associated with *A. temenus*, but differs in having a narrower axis marked by more rings.

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 53.

*Formation and locality.*—Middle Cambrian, thin-bedded, greenish gray limestone interbedded in ochreous and green, argillaceous shales; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

ANOMOCARE, species undetermined.

This form is represented by a fragment of the central portion of a large head much like that of *Anomocare alcinoe* Walcott.<sup>a</sup> The frontal limb and broad rim are similar to those of *Anomocare temenus* Walcott.<sup>b</sup> It is the youngest representative of this type of *Anomocare* as it occurs near the summit of the Cambrian system in China.

*Formation and locality.*—Upper Cambrian, limestone interbedded in green shales; 4 miles southeast of Yaü-t'o, near Wu-t'ai-hién, Shan-si, China.

Collected by Eliot Blackwelder.

Genus ANOMOCARELLA Walcott.

*Anomocarella* WALCOTT, 1905, Proc. U. S. Nat. Mus., XXIX, p. 54.

ANOMOCARELLA CONTIGUA, new species.

This species is represented by an imperfect specimen of the central portions of the head, and numerous associated pygidia and free cheeks. The head differs from that of *Anomocarella chinensis* Walcott<sup>c</sup> in having a more conical glabella, with the sides converging toward the front, instead of being subparallel. The associated pygidium has a shorter axis than that associated with *A. chinensis*, and a broader, smoother border.

*A. contigua* occurs at the same locality as *A. chinensis*, but at a slightly higher horizon.

*Formation and locality.*—Middle Cambrian, lower central portion of Ch'ang-hia formation, in dense, gray limestone, interbedded in green, nodular shale; 2 miles south of Yen-chuang, Sin-t'ai District, Shantung, China.

Collected by Eliot Blackwelder.

ANOMOCARELLA IRMA, new species.

This species is represented by two specimens of the central portions of the head. These indicate that the head was semicircular in outline, and moderately convex. Glabella prominent, convex, sides straight and converging gently toward the front which is broadly rounded; the only traces of glabellar furrows are two faint scars near the front, which extend from the outer margin nearly to the median line of the head; occipital furrow well defined, separating a rounded, rather strong occipital ring; dorsal furrow distinctly defined at the sides and less clearly marked in front of the glabella.

<sup>a</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 47.

<sup>b</sup> Idem, p. 53.

<sup>c</sup> Idem, p. 57.

Fixed cheeks narrow, almost lost in the palpebral lobes; in front of the latter they extend forward and downward as narrow, convex ridges, merging into the frontal limb; palpebral lobes strong, about one-third the length of the head; ocular ridge merged into the fixed cheek on the back side and defined by a short, steep slope on the front side; frontal limb of medium width, sloping with very little convexity to the narrow furrow separating the frontal limb from the relatively broad, flattened frontal rim; the length of the latter in front of the glabella is a little more than that of the frontal limb.

Surface slightly roughened by elevated, irregular, more or less inosculating lines upon which numerous minute nodes occur. The result is that on some portions the surface appears to be finely granulose, and on others finely punctate, the interspaces between the inosculating lines giving the punctate appearance and the nodes on the lines the granulose appearance. A head 4.5 mm. in length has the same width at the palpebral lobes, exclusive of the free cheeks.

*Observations.*—The nearest related species is *Anomocarella ? bura* Walcott.<sup>a</sup> It differs from the latter in having a short frontal limb between the glabella and frontal rim, relatively larger palpebral lobes, and a stronger dorsal furrow about the glabella.

*Formation and locality.*—Upper Cambrian, limestone interbedded in green shales; 4 miles southeast of Yañ-t'ò, near Wu-t'ai-hièn, Shan-si, China.

Collected by Eliot Blackwelder.

Genus PTYCHASPIS Hall.

PTYCHASPIS BELLA, new species.

This species is represented by a single specimen of the central portions of the head, exclusive of the postero-lateral limbs and free cheeks. Glabella subrectangular in outline, moderately convex, and crossed by a backward arching furrow which separates a narrow segment from the large anterior lobe, which has a length of 6.5 mm. and a width at the center of 5 mm.; the anterior lobe of the glabella is marked close to the dorsal furrow by very short furrows which indicate the second pair of glabellar furrows; the posterior transverse furrow is rather broad and deep at the sides, becoming somewhat shallower at the center; the posterior segment has a uniform width across the central portions, widening out at the ends in front; occipital furrow transversely rounded and rather deep; occipital ring transverse, slightly convex, and about the same width as the posterior segment of the glabella; dorsal furrow deep and strong at the sides and in front of the glabella.

<sup>a</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 56.

Fixed cheeks narrow and rising abruptly from the dorsal furrow, nearly flat opposite the palpebral lobes; they slope abruptly downward toward the posterior furrow and toward the frontal rim; palpebral lobes narrow, rounded, and separated from the fixed cheeks by strong, narrow furrows; frontal rim convex, prominent, and separated from the glabella by the deep dorsal furrow, and from the fixed cheeks by a narrow, deep furrow that extends obliquely outward and forward from opposite each antero-lateral angle of the glabella.

The surface of the glabella is marked by raised, irregular, more or less inosculating, sharp ridges, the general direction of which is transverse to the axis of the glabella; the fixed cheeks are marked by ridges somewhat like those on the glabella, which are subparallel to the dorsal furrow and the furrow within the palpebral lobes; the ridges on the frontal limb are broken up into large granulations by the inosculating furrows. A head 11 mm. in length has a width of 12 mm. at the palpebral lobes.

*Observations.*—The general form of the central parts of the head of this species suggests *Ptychaspis acamus* Walcott.<sup>a</sup> It differs from the latter in the form of the glabella in front of the transverse glabellar furrow, the elevated lines on the fixed cheeks instead of granulations, and in minor details of the occipital and glabellar furrows.

*Formation and locality.*—Upper Cambrian, blue, dolomitic limestone, probably equivalent to the Ch'au-mi-tien limestone of Shantung; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

#### Genus PTYCHOPARIA Hawle and Corda.

##### PTYCHOPARIA COMUS, new species.

Of this species only the central portions of two small heads are known. The glabella and fixed cheeks are convex; glabella convex, truncate-conical, and marked by three pairs of faint furrows; occipital furrow rather broad, rounded, and moderately deep; occipital ring narrow at the sides, widening gradually toward the center, where it is a little elevated above the plane of the glabella and not much wider than the occipital furrow; dorsal furrow clearly defined on the sides and slightly marked in front of the glabella.

Fixed cheeks narrow, not over one-fourth the width of the glabella; palpebral lobes about one-third the length of the head, somewhat nearer the posterior than the frontal margin of the head; ocular ridge short, and not prominent, it terminates a little back of the antero-lateral angle of the glabella; frontal limb narrow, very slightly convex, and sloping downward with a well defined furrow separating it from the strong, rounded, thickened frontal rim; four small, shallow

<sup>a</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 69.



pits occur in the furrow, one strong one on each side of the center, and one faint one opposite the outer edges of the glabella.

Surface finely granulose under a strong lens. The largest head has a length of 5 mm.

*Observations.*—This species belongs to the forms intermediate between *Ptychoparia* and *Liostracus*. It is distinguished from other species of the Chinese Cambrian by its rounded, strong frontal rim, and very slightly tapering glabella, in the latter respect recalling such forms of *Anomocure* as *A. butes* Walcott,<sup>a</sup> *A. alcinoe* Walcott,<sup>b</sup> and *A. minus* Dames,<sup>c</sup> from the Cambrian of China.

*Formation and locality.*—Middle Cambrian, oolitic limestone; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

PTYCHOPARIA INFLATA, new species.

This species is represented by two specimens of the central portions of the head, exclusive of the free cheeks. The parts preserved indicate that the head was rather strongly convex, and semicircular in outline. Glabella moderately convex, with the length and width at the base equal; the sides converge slightly toward the rather broadly rounded antero-lateral angles; front nearly transverse; surface marked by a clearly defined posterior pair of furrows, which extend obliquely inward and backward, separating a subtriangular postero-lateral lobe; a second pair of short, lightly defined furrows occurs about one-third the distance between the posterior furrows and the front of the glabella; occipital furrow rather broad and shallow toward the center, narrower and deeper at the sides; occipital ring narrow at the sides, increasing in width toward the center where it is rather broad, and slightly convex; dorsal furrow clearly defined at the sides and front of the glabella.

Fixed cheeks about one-third the width of the glabella, convex, rising from the dorsal furrow and curving over to the facial sutures and the furrows separating them from the palpebral lobes; palpebral lobes narrow, slightly elevated, and about one-third the length of the head; ocular ridges indicated more by the depressions in front of them than by their elevation above the general surface of the fixed cheeks; postero-lateral limb short, and marked by a broad, shallow furrow within the strong, rounded posterior rim; frontal limb convex, inflated at the center so as to form an elongate swelling somewhat similar to that of *Agraulos(?) melie* (p. 581); the line of demarcation between the fixed cheeks and the frontal limb is rather indefinite, the fixed cheeks merging into the downward sloping surface of the frontal limb; there is no line of demarcation to indicate a distinct frontal rim.

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 49.

<sup>b</sup>Idem, p. 47.

<sup>c</sup>China, Richthofen, IV, 1883, p. 15.

Surface smooth to the unaided eye, and under a strong lens slightly roughened with what appear to be irregular, inosculating, very slightly elevated lines, and a few low, scattered tubercles. The type and largest specimen of the head has a length of 9 mm.

*Observations.*—This species at first suggests *Agraulos(?) melie* (p. 581) owing to the swelling on the frontal limb, the glabella, however, is much broader in proportion to its length, and its furrows are those of *Ptychoparia* rather than *Agraulos*.

*Formation and locality.*—Middle Cambrian, lower portion of oolitic limestone series; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

#### PTYCHOPARIA LILIA, new species.

This species is represented by a single fragment of a head, preserving the glabella, the left fixed cheek, and the frontal limb and rim. It is characterized by the convex glabella, marked by three short, very slightly indicated pairs of glabellar furrows, and the strong, rounded frontal rim separated from the glabella by a very short frontal limb.

The fixed cheeks are moderately convex and marked by faint, obliquely transverse ocular ridges; palpebral lobes unknown; frontal limb narrow, slightly convex; frontal rim strong, rounded, thickened in front, and separated from the frontal limb by a shallow, narrow furrow.

Surface formed by a network of fine, irregular, inosculating, very slightly elevated lines. This surface, when partially worn, has a punctate appearance owing to the shallow places between the lines. The type and only specimen of the head has a length of 5 mm.

The associated free cheeks have a strong, rather broad border that is continued posteriorly as a strong and rather long spine.

*Observations.*—This species differs from *Ptychoparia (Liostracus) toxeus* Walcott<sup>a</sup> in having a broader, stronger frontal rim, and shorter frontal limb.

*Formation and locality.*—Middle Cambrian, Ki-chön limestone, in brown gray, partly oolitic bed, 10 feet above red shales, supposed to correspond to the Man-t'o shales of the Shan-tung sections; 4.5 miles south of Wu-t'ai-hiön, Shan-si, China.

Collected by Eliot Blackwelder.

#### PTYCHOPARIA NEREIS, new species.

This form is represented by several heads, exclusive of the free cheeks. Glabella and fixed cheeks are moderately convex; glabella prominent, truncato-conical, converging very gently from the base to the slightly rounded front; surface marked by three pairs of short, very slightly impressed furrows, and a very obscure, longitudinal

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 83.

median ridge; occipital furrow shallow but clearly defined; occipital ring nearly flat, sloping from the shallow furrow slightly upward to the posterior margin, it narrows at the sides to two-thirds of its width at the center; dorsal furrow narrow, shallow, and clearly defined at the sides of the glabella, in front it is little more than the angle formed by the union of the glabella and frontal limb.

Fixed cheeks narrow, about one-third the width of the glabella, slightly convex opposite the palpebral lobes, and merging into the frontal limb in front of the ocular ridges, and sloping more gently backward to the posterior furrow; palpebral lobes narrow, about one-third the length of the head, and separated from the fixed cheeks by shallow furrows; postero-lateral limb short, and marked by a rather broad, shallow posterior furrow within a very narrow posterior margin; frontal limb short, sloping down to the very narrow, slightly defined furrow that separates it from the nearly flat, narrow frontal rim.

Surface slightly roughened, but from its condition it is impossible to state whether it is like the surface of *Ptychoparia lilia* (p. 588). The largest head in the collection has a length of 3.5 mm.

*Observations.*—The subrectangular glabella is somewhat like that of *Ptychoparia aelis* Walcott,<sup>a</sup> but the short frontal limb and flat rim distinguish it from the latter species.

It is associated with *Ptychoparia vesta* (p. 590), from which it differs in the form of the glabella and palpebral lobes.

A form closely related to this occurs about 100 feet lower at the same locality and section.

*Formation and locality.*—Middle Cambrian, lower portion of oolitic limestone series; 4 miles east of Fang-lan-chön, Shau-si, China.

Collected by Eliot Blackwelder.

PTYCHOPARIA UNDATA, new species.

This species is represented by four specimens of the central portions of the head, exclusive of the free cheeks. These show that the head was semicircular in outline and rather strongly convex. Glabella convex, irregularly subquadrangular in outline, it narrows slightly from the base toward the front; the postero-lateral angles are rounded, and the anterior angles more broadly rounded into the slightly curved front; three pairs of glabellar furrows are indicated by slight depressions that extend in from the margin about one-half the distance to the median line; the posterior pair extends obliquely backward so as to indicate oval postero-lateral lobes; occipital ring rounded and strongly defined, narrow at the sides, gradually widening toward the center, which is slightly above the plane of the surface of the glabella; occipital furrow narrow, rounded, distinct, and curving slightly for-

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 75.

ward toward the center; dorsal furrow rather sharply defined at the sides and shallow in front of the glabella.

Fixed cheek narrow, and elevated into a ridge opposite the palpebral lobe, which is separated by a narrow, curved furrow; ocular ridge low, narrow, and passing obliquely from the anterior end of the palpebral lobe to the antero-lateral angle of the glabella; postero-lateral limb narrow, about as long as the width of the front of the glabella, and marked by a rather strong furrow within an elevated, narrow posterior rim; frontal limb narrow, merging in front into the narrow, slight furrow produced by the union of the frontal limb and frontal rim; frontal rim of medium width, moderately convex, and rounding down to meet the frontal limb.

Surface appears to be minutely and irregularly punctate under a lens of moderate power. Under a strong lens it is shown to be formed by a network of irregularly inosculating, raised lines, that are so interrupted in places as to give a granular appearance to the surface. The largest head in the collection has a length of 5 mm.

*Observations.*—This species is most nearly related to *Ptychoparia comus* (p. 586); it differs in having a proportionately shorter glabella, and a more convex, thickened frontal rim. It differs from *Ptychoparia (Liostracus) thraso* Walcott<sup>a</sup> in its shorter frontal limb and proportionally longer glabella.

This species is associated with *Ptychoparia comus* and *Solenopleura pauperata* (p. 593).

*Formation and locality.*—Middle Cambrian, oolitic limestone; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

#### PTYCHOPARIA VESTA, new species.

Of this species the central portions of the head are known, and associated free cheeks and pygidia. The parts of the head preserved show it to have been moderately convex, and semicircular in outline. Glabella convex, not very prominent, broadly truncate-conical in outline; antero-lateral angles rounded, front gently curved; between the base and front the sides are slightly incurved at a point about two-thirds the distance from the base to the front; three pairs of glabellar furrows that extend about one-half the distance from the sides toward the center are faintly impressed; occipital furrow narrow, shallow, and transverse; occipital ring narrow at the sides, widening toward the center where the surface is on the plane of the glabella; dorsal furrow narrow and clearly defined at the sides, and shallow in front of the glabella.

Fixed cheeks a little more than one-half the width of the glabella, nearly flat opposite the palpebral lobes, curving gently downward pos-

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 85.

teriorly to the posterior furrow, and rather abruptly downward to merge into the frontal limb; palpebral lobes a little less than one-half the length of the head, narrow, and separated from the fixed cheeks by rather strong, curved furrows; ocular ridge low, rather strong, and extending obliquely forward from the anterior edge of the palpebral lobe to the side of the glabella, just back of its antero-lateral angle; frontal limb short, gently convex, and sloping down from the front of the glabella to the rounded furrow formed by its merging with the frontal rim; frontal rim nearly flat and rising at a low angle from the furrow.

Surface smooth to the unaided eye, finely punctate under a strong lens. The largest head referred to this species has a length of 9 mm., and the specimen selected as the type, a length of 4 mm., with a width at the outer edge of the palpebral lobes of 6 mm.

The associated free cheek has the same type of nearly flat rim as the rim in front of the glabella; this is extended at the postero-lateral angle into a moderately strong, sharp spine; the body of the cheek rises to the base of the eye lobe with very little convexity; it is separated from the lateral and posterior borders by a shallow furrow; the surface is marked by irregular lines radiating from the base of the eye lobe toward the furrow within the outer margin.

The associated pygidium has a planulate border that merges into the slope of the pleural lobes; axis convex, about three-fourths the length of the pygidium, and marked by three shallow transverse furrows that are continued across the pleural lobes out onto the planulate margin.

*Observations.*—The general form of the head of this species is much like that of *Ptychoparia impar* Walcott.<sup>a</sup> It differs in having a flatter frontal rim, less convex frontal limb, stronger glabellar furrows, and larger palpebral lobes. From *Ptychoparia (Liostracus) megalurus* Dames<sup>b</sup> it differs by having a more subquadrangular glabella, and larger palpebral lobes.

*Formation and locality.*—Middle Cambrian, lower portion of oolitic limestone series; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

#### PTYCHOPARIA, species undetermined.

This form is represented by a minute head 1.25 mm. in length. It has an elongate glabella of the type of *Ptychoparia theano* Walcott,<sup>c</sup> but its palpebral lobes are longer than in that species. It may be the young of *Ptychoparia uclis* Walcott.<sup>d</sup>

A small head about 2 mm. in length of about the same character as

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 78.

<sup>b</sup>*Liostracus megalurus* Dames, 1883, China, Richthofen, IV, p. 20.

<sup>c</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 82.

<sup>d</sup>Idem, p. 75.

the one mentioned above, but differing from it in having a shorter frontal limb, occurs in the upper portion of the Ki-chóu limestone, 4 miles east of Fang-lan-chón, Shan-si, China. The locality of the head first described is as follows:

*Formation and locality.*—Middle Cambrian, in a brown, oolitic limestone near the base of the Ki-chóu formation; 4 miles south southwest of Tung-yü-chón, Shen-si, China.

Collected by Eliot Blackwelder.

PTYCHOPARIA(?) MAIA, new species.

This species is represented by one fairly good specimen of the central portions of the head, to which the description of *Ptychoparia?* *bromus* Walcott<sup>a</sup> applies, with the exception that the latter has broader fixed cheeks and a flatter frontal rim. *P.?* *maia* also has short, strong ocular ridges that are not present in *P.?* *bromus*.

The type specimen of the head has a length of 4.25 mm.

*Formation and locality.*—Middle Cambrian, in a brown, oolitic limestone near the base of the Ki-chóu formation; 4 miles south-southwest of Tung-yü-chón, Shen-si, China.

Collected by Eliot Blackwelder.

LIOSTRACUS Angelin, subgenus of PTYCHOPARIA.

PTYCHOPARIA (LIOSTRACUS) INTERMEDIA, new species.

This is a form intermediate between *Ptychoparia tolus* Walcott<sup>b</sup> and *Ptychoparia* (*Liostracus*) *subrugosa* (p. 592). It is represented by the well preserved central portions of the head of a single specimen. It differs from both of the species mentioned by having a proportionally shorter, broader glabella, with a strong, uniform dorsal furrow about it, and two pairs of less strongly indicated glabellar furrows; also in the details of the frontal limb and rim.

The surface of *Ptychoparia* (*L.*) *intermedia* is marked by a few scattered, rather large tubercles and many very fine tubercles. A head 8 mm. in length has a width at the outer edge of the palpebral lobes of 9 mm., with a convexity of 2 mm. above the plane of the margin of the head.

*Formation and locality.*—Middle Cambrian, upper part of oolitic formation; Ch'au-mi-tien, Shan-tung, China.

Collected by Eliot Blackwelder.

PTYCHOPARIA (LIOSTRACUS) SUBRUGOSA, new species.

This species is represented by two specimens of the head, exclusive of the free cheeks. These portions of the head are subrectangular

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 76.

<sup>b</sup>Idem, p. 82.

in outline, strongly convex. Glabella prominent, strongly convex, with its sides converging from a width of 6.5 mm. at the base to 4 mm. at the front, in a glabella 6.5 mm. long, exclusive of the occipital furrow and ring; front arched, with a shallow pit in the dorsal furrow where the sides and front unite; the glabella is marked by three pairs of shallow, rather broad glabellar furrows, the posterior pair of which extends obliquely inward and backward about one-third the distance across the glabella; occipital furrow rounded and rather deep; occipital ring narrow and moderately convex at the sides, gradually increasing in convexity and width toward the center, where a small node occurs; dorsal furrow strong at the sides and in front of the glabella.

Fixed cheeks about half as wide as the glabella at its base, convex at the center, and sloping gently backward to the posterior furrow and more abruptly downward to the frontal limb; palpebral lobes central and small; ocular ridge rather strong, rounded, and extending from the anterior rim of the palpebral lobe obliquely forward across the fixed cheek to a point just back of the pit at the antero-lateral angle of the glabella; frontal limb of medium width, slightly convex, and passing into the rounded furrow within the rounded, strong, convex frontal rim.

Surface with prominent, fine granulations over the glabella and fixed cheeks, with the exception of the smooth places indicating the glabellar furrows. A head 10.5 mm. in length has a width of 14 mm. at the palpebral lobes.

*Observations.*—In form this species is closely related to *Psychoparia* (*Liostracus*) *thraso* Walcott.<sup>a</sup> It differs in having a more convex fixed cheek and frontal rim, and in having a granulated instead of a smooth surface. From *Psychoparia tolus* Walcott<sup>b</sup> it differs in having a proportionally more conical glabella, stronger frontal rim, and finer granulose surface.

*Formation and locality.*—Middle Cambrian, base of Ch'ang-hia oolite; 2.2 miles southwest of Yen-chuang, Sin-t'ai District, and in upper part of oolitic formation at Ch'au-mi-tien, Shan-tung, China.

Collected by Eliot Blackwelder.

#### Genus SOLENOPLEURA Angelin.

##### SOLENOPLEURA PAUPERATA, new species.

This species is represented by the central portions of the head, exclusive of the free cheeks and the occipital ring. The portions preserved show that the head was semicircular, and rather strongly convex. Glabella truncato-conical, rounded in front, strongly convex, and marked by three pairs of very short, slightly impressed furrows; the fragment of the occipital furrow remaining shows it to have been

<sup>a</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 85.

<sup>b</sup> Idem, p. 82.

narrow and rather deep; occipital ring unknown; dorsal furrow narrow and rather deep at the sides, and clearly defined in front of the glabella.

Fixed cheeks about two-thirds the width of the glabella, convex, and curving gently to the front and back; palpebral lobes central and small; no traces of ocular ridges; postero-lateral limb about as long as the width of the glabella, and marked by a sharply impressed furrow within a narrow, rounded posterior rim; the line of demarcation between the front of the glabella and the frontal rim is a rather deep, narrow furrow, no traces of a frontal limb being present; frontal rim strong, rounded, and broadly curved in front.

Surface minutely granular, with a few larger granules scattered over the surface of the glabella, and a number of slightly larger granules scattered over the surface of the fixed cheeks. The type and only specimen of the head has a length of 3 mm., exclusive of the occipital ring.

*Observations.*—This species is characterized by the absence of a frontal limb, and its broadly conical glabella, in these respects differing from *Solenopleura agna* Walcott<sup>a</sup> and *S. heroe* Walcott.<sup>b</sup> It also differs from the two mentioned species by having a more finely granulated surface.

*Formation and locality.*—Middle Cambrian; 4 miles south-southwest of Tung-yü-chön, Shen-si, China.

Collected by Eliot Blackwelder.

#### Genus DOLICHOMETOPUS Angelin.

##### DOLICHOMETOPUS HYRIE, new species.

This species is represented by a single specimen of the central portions of the head, and an associated free cheek and pygidium. Glabella moderately convex, with the sides slightly converging toward the broadly rounded front; glabellar furrows faintly impressed; the posterior pair extends obliquely inward and backward, obscurely outlining a subtriangular lobe on each side; also two pairs of short, faintly impressed furrows that extend in at nearly right angles to the sides of the glabella; occipital furrow shallow, somewhat deeper at the sides than in the center; occipital ring narrow at the sides, widening gradually toward the center where it is of medium width, slightly convex, and rising but little above the general surface of the glabella; dorsal furrow shallow, indicated by the union of the sloping sides and front of the glabella with the fixed cheeks and frontal limb.

Fixed cheeks narrow, nearly flat opposite the palpebral lobes, and sloping gently to the front and back; what is preserved of the palpebral lobes indicates that they were elongate, extending about one-third or more of the length of the head; a narrow, slightly elevated ocular

<sup>a</sup> Proc. U. S. Nat. Mus., XXIX, 1905, p. 89.

<sup>b</sup> Idem, p. 91.



ridge extends obliquely across the narrow fixed cheek; frontal rim short and nearly flat; the curved angle at the union of the fixed cheeks and glabella gives the impression that the frontal rim is slightly concave.

Associated free cheek subtriangular, with a long genal spine.

Surface, as seen by a strong lens, slightly roughened with minute granules. The type and only specimen in the collection has a length of 7.5 mm.

The associated pygidium is transverse, semicircular, and convex; axial lobe convex, a little more than three-fourths the length of the pygidium, and crossed by three rather clearly defined, narrow furrows, that differentiate three rings and a terminal portion; the outline of the axis is continued by a low swelling that extends from the end of the convex axis to the posterior margin; the furrows crossing the axis curve outward and slightly backward across the pleural lobes to the margin of the border; they are broader than the furrows on the axis and separate three rather clearly defined segments from a narrow frontal rim and a posterior portion back of the axis; border relatively narrow, and sloping gently from the base of the pleural lobe to the outer margin; it arches slightly inward back of the axis. The largest specimen has a width of 26 mm., with a length of 14 mm. A small specimen 15 mm. in width has a less clearly defined border, and in other respects resembles the pygidium associated with *D. deois* Walcott.<sup>a</sup>

*Observations.*—This species differs from *D. alceste* Walcott<sup>a</sup> in having a proportionately longer frontal rim, less distinctly defined glabellar furrows, and in being less convex. From other described species of the Chinese Cambrian it differs in having a glabella that narrows toward the front instead of expanding. The associated pygidium is much like that associated with *D. deois* Walcott.<sup>a</sup> It differs in having a narrower, more clearly defined border, and more clearly defined furrows upon the pleural lobes.

*Formation and locality.*—Middle Cambrian, lower portion of oolitic limestone series; 4 miles east of Fang-lan-chön, Shan-si, China.

Collected by Eliot Blackwelder.

<sup>a</sup>Proc. U. S. Nat. Mus., XXIX, 1905, p. 94.