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II

No. 4.—CAMBRIAN FAUNAS OF CHINA

WITH FOUR PLATES

BY

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INTRODUCTION

This is the third preliminary paper on the Cambrian faunas of China.¹ It includes the description of a few new species from the collection made by Mr. Eliot Blackwelder of the Carnegie Institution of Washington Expedition to China in 1903-04; a larger number of species are from collections made in Manchuria by Dr. Joseph P. Iddings, who very kindly offered to make a collection for the Smithsonian Institution in the Province of Liau-tung, where Baron Richthofen collected the Cambrian trilobites described by Dr. Wilhelm Dames² and the Cambrian brachiopods described by Dr. Emanuel Kayser.³ Other species are included, see list on pages 72-73.

In the revision of the new material from Liau-tung, Shan-tung, and Shan-si, it became necessary to study the references of the

¹ Proc. U. S. National Museum, Vol. 29, 1905, pp. 1-106.

Idem, Vol. 30, 1906, pp. 563-595.

² China, by Richthofen, vol. 4, pp. 3-33.

³ Idem, pp. 33-36.

species and genera. This resulted in the founding of several new genera and the changing of the generic reference of a number of the species described in the first two preliminary papers. The changes made are shown in the accompanying list, the first column giving the preliminary generic references and the second column the genera to which the species are now referred:

LIST OF NAMES CHANGED

<i>Former generic reference.</i>	<i>Present generic reference.</i>
<i>Agnostus koerferi</i> Monke, 1903	= <i>Agnostus douvillei</i> Bergeron
<i>Agraulos abaris</i> Walcott, 1905	= <i>Inouyia abaris</i> (Walcott)
<i>Agraulos acalle</i> Walcott, 1905	= <i>Inouyia</i> ? <i>acalle</i> (Walcott)
<i>Agraulos agenor</i> Walcott, 1905	= <i>Levisia agenor</i> (Walcott)
<i>Agraulos armatus</i> Walcott, 1906	= <i>Inouyia</i> ? <i>armatus</i> (Walcott)
<i>Agraulos</i> (?) <i>capax</i> Walcott, 1906	= <i>Inouyia capax</i> (Walcott)
<i>Agraulos divi</i> Walcott, 1905	= <i>Inouyia divi</i> (Walcott)
<i>Agraulos</i> (?) <i>melie</i> Walcott, 1906	= <i>Inouyia melie</i> (Walcott)
<i>Agraulos regularis</i> Walcott, 1906	= <i>Inouyia</i> ? <i>regularis</i> (Walcott)
<i>Amphoton</i> Lorenz, 1906	= <i>Dolichometopus</i> Angelin
<i>Amphoton steinmanni</i> Lorenz, 1906	= <i>Dolichometopus deois</i> Walcott
<i>Anomocare bergioni</i> Walcott, 1905	= <i>Anomocarella bergioni</i> (Walcott)
<i>Anomocare bianos</i> Walcott, 1905	= <i>Coosia</i> ? <i>bianos</i> (Walcott)
<i>Anomocare bigsbyi</i> Walcott, 1906	= <i>Anomocarella bigsbyi</i> (Walcott)
<i>Anomocare biston</i> Walcott, 1905	= <i>Anomocarella biston</i> (Walcott)
<i>Anomocare</i> ? <i>butes</i> Walcott, 1905	= <i>Anomocarella butes</i> (Walcott)
<i>Anomocare commune</i> Lorenz, 1906	= <i>Anomocarella chinensis</i> (Walcott)
<i>Anomocare daunus</i> Walcott, 1905	= <i>Coosia</i> ? <i>daunus</i> (Walcott)
<i>Anomocare decelus</i> Walcott, 1905	= <i>Coosia decelus</i> (Walcott)
<i>Anomocare erioptia</i> Walcott, 1906	= <i>Ptychoparia</i> (<i>Emmrichella</i>) <i>erioptia</i> (Walcott)
<i>Anomocare limbatum</i> Angelin	= <i>Coosia</i> (?) <i>limbatum</i> (Angelin)
<i>Anomocare speciosum</i> Lorenz, 1906	= <i>Anomocarella speciosum</i> (Lorenz)
<i>Anomocare tatian</i> Walcott, 1905	= <i>Anomocarella tatian</i> (Walcott)
<i>Anomocare temenus</i> Lorenz, 1906	= <i>Anomocarella temenus</i> (Walcott)
<i>Anomocare temenus</i> Walcott, 1905	= <i>Anomocarella temenus</i> (Walcott)
<i>Anomocarella</i> ? <i>bura</i> Walcott, 1905	= <i>Lisania bura</i> (Walcott)
<i>Anomocarella carne</i> Walcott, 1905	= <i>Coosia carne</i> (Walcott)
<i>Anomocarella contigua</i> Walcott, 1906	= <i>Anomocarella albion</i> Walcott
<i>Arionellus agonius</i> Walcott, 1905	= <i>Lisania agonius</i> (Walcott)
<i>Arionellus ajax</i> Walcott, 1905	= <i>Lisania ajax</i> (Walcott)
<i>Arionellus alala</i> Walcott, 1905	= <i>Lisania alala</i> (Walcott)
<i>Bathyriscus asiaticus</i> Lorenz, 1906	= <i>Dolichometopus deois</i> Walcott
<i>Bradoria bergeroni</i> Walcott, 1905	= <i>Aluta bergeroni</i> (Walcott)
<i>Bradoria enyo</i> Walcott, 1905	= <i>Aluta enyo</i> (Walcott)
<i>Bradoria eris</i> Walcott, 1905	= <i>Aluta eris</i> (Walcott)
<i>Bradoria fragilis</i> Walcott, 1905	= <i>Aluta fragilis</i> (Walcott)
<i>Bradoria sterope</i> Walcott, 1905	= <i>Aluta sterope</i> (Walcott)
<i>Bradoria woodi</i> Walcott, 1905	= <i>Aluta woodi</i> (Walcott)

- Calymene ? sinensis* Bergeron, 1899 = *Blackwelderia sinensis* (Bergeron)
Conocephalites subquadratus Dames, = *Anomocare subquadratus* (Dames)
 1883
Conocephalites typus Dames, 1883 = *Ptychoparia typus* (Dames)
Craniella ?? sp. Walcott, 1905 = *Discinopsis sulcatus* Walcott
Damesella Walcott, 1905 = *Stephanocare* Monke
Damesella chione Walcott, 1905 = *Stephanocare richthofeni* Monke
Damesella sinensis Walcott, 1905 = *Stephanocare ? sinensis* (Bergeron)
Dicelloccephalus ? sinensis Bergeron, = *Stephanocare ? sinensis* (Bergeron)
 1899
Dikelocephalus ? baubo Walcott, 1905 = *Ptychaspis baubo* (Walcott)
Dikelocephalus ? brizo Walcott, 1905 = *Ptychaspis brizo* (Walcott)
Dorypygella Walcott, 1905 = *Teimistion* Monke
Dorypygella alastor Walcott, 1905 = *Blackwelderia alastor* (Walcott)
Dorypygella alcon Walcott, 1905 = *Teimistion alcon* (Walcott)
Dorypygella typicalis Walcott, 1905 = *Teimistion typicalis* (Walcott)
Hoeferia Redlich, 1901 = *Redlichia* Cossman, 1902
Liostracus megalurus Dames, 1883 = *Anomocare megalurus* (Dames)
Menocephalus adrastia Walcott, 1905 = *Levisia adrastia* (Walcott)
Menocephalus belenus Walcott, 1905 = *Lisania belenus* (Walcott)
Menocephalus sp. Walcott, 1905 = *Anomocare* sp. (Walcott)
Obolus (Lingulepis) eros Walcott, = *Lingulella (Lingulepis) eros*
 1905 (Walcott)
Obolus (Lingulepis ?) sp. undt., = *Lingulella (Lingulepis ?) sp.*
 Walcott, 1906 undt. (Walcott)
Olenoides ? cilix Walcott, 1905 = *Blackwelderia cilix* (Walcott)
Olenoides leblanci Bergeron, 1899 = *Blackwelderia sinensis* (Bergeron)
Orthis linnarssoni Kayser, 1883 = *Eoorthis linnarssoni* (Kayser)
Orthis (Plectorthis) agreste Walcott, = *Eoorthis agreste* (Walcott)
 1906
Orthis (Plectorthis) doris Walcott, = *Eoorthis doris* (Walcott)
 1905
Orthis (Plectorthis) kichouensis = *Eoorthis kichouensis* (Walcott)
 Walcott, 1906
Orthis (Plectorthis) linnarssoni = *Eoorthis linnarssoni* (Kayser)
 Walcott, 1905
Orthis (Plectorthis) sp. undt., = *Eoorthis sp. undt.* (Walcott)
 Walcott, 1906
Plectorthis kayseri Walcott, 1905 = *Eoorthis kayseri* (Walcott)
Plectorthis pagoda Walcott, 1905 = *Eoorthis pagoda* (Walcott)
Ptychoparia ? batia Walcott, 1905 = *Chuangia batia* (Walcott)
Ptychoparia ? bromus Walcott, 1905 = *Ptychoparia (Emmrichella) bromus*
 (Walcott)
Ptychoparia ceus Walcott, 1905 = *Liostracina krausei* Monke
Ptychoparia granulosa Walcott, 1905 = *Ptychoparia granosa* Walcott
Ptychoparia comus Walcott, 1906 = *Anomocarella comus* (Walcott)
Ptychoparia constricta Walcott, 1905 = *Ptychoparia (Emmrichella) con-*
stricta (Walcott)
Ptychoparia dryope Walcott, 1905 = *Conocephalina ? dryope* (Walcott)
Ptychoparia inflata Walcott, 1906 = *Inouyia ? inflata* (Walcott)

- Ptychoparia* (?) *maia* Walcott, 1906 = *Conocephalina maia* (Walcott)
Ptychoparia mantoensis Walcott, 1905 = *Ptychoparia* (*Emmrichella*)
mantoensis (Walcott)
Ptychoparia nereis Walcott, 1906 = *Anomocare* ? *nereis* (Walcott)
Ptychoparia tellus Walcott, 1905 = *Lonchocephalus tellus* (Walcott)
Ptychoparia tenes Walcott, 1905 = *Anomocarella tenes* (Walcott)
Ptychoparia theano Walcott, 1905 = *Ptychoparia* (*Emmrichella*)
theano (Walcott)
Ptychoparia titiana Walcott, 1905 = *Inouyia titiana* (Walcott)
Ptychoparia undata Walcott, 1906 = *Anomocarella undata* (Walcott)
Ptychoparia vesta Walcott, 1906 = *Conocephalina vesta* (Walcott)
Ptychoparia sp. undt., Walcott, 1906 = *Conocephalina* sp. undt. (Walcott)
Ptychoparia (*Liostracus*) *intermedia* = *Solenopleura intermedia* (Walcott)
Walcott, 1906
Ptychoparia (*Liostracus*) *subrugosa* = *Anomocarella subrugosa* (Walcott)
Walcott, 1906
Ptychoparia (*Liostracus*) *thraso* = *Anomocarella thraso* (Walcott)
Walcott, 1905
Ptychoparia (*Liostracus*) *toxews* = *Anomocarella toxews* (Walcott)
Walcott, 1905
Ptychoparia (*Liostracus*) *trogus* = *Anomocarella trogus* (Walcott)
Walcott, 1905
Ptychoparia (*Liostracus*) *tutia* = *Anomocarella tutia* (Walcott)
Walcott, 1905
Ptychoparia (*Proampyx*) *burca* = *Proampyx burea* (Walcott)
Walcott, 1905
Shantungia Lorenz, 1906 = *Chuangia* Walcott
Shantungia Walcott, 1905 = *Shantungia* Walcott
Shantungia buchruckeri Lorenz, 1906 = *Chuangia nitida* Walcott
Solenopleura abderus Walcott, 1905 = *Menocephalus abderus* (Walcott)
Solenopleura acantha Walcott, 1905 = *Menocephalus acantha* (Walcott)
Solenopleura acidalia Walcott, 1905 = *Menocephalus acidalia* (Walcott)
Solenopleura belus Walcott, 1905 = *Conocephalina belus* (Walcott)
Stephanocare sinensis Monke, 1903 = *Blackwelderia sinensis* (Bergeron)
Syntrophia orientalis Walcott, 1905 = *Huenella orientalis* (Walcott)

The following is a list of the species described or figured in this paper, with page and plate and figure references to the plates accompanying this paper. The list includes not only the new species from China, but the old species which have been made the types of new genera (*Ptychoparia* (*Emmrichella*) *theano*, *Inouyia capax*, *Lisania bura*, *Chuangia batia*, and *Levisia agenor*); three new species from Alabama (*Coosia superba*, *Coosia robusta*, and *Anomocare convexa*), *Coosia superba* being the type of that genus; and the type of the genus *Anomocare* (*Anomocare laeve*).

Micromitra (*Paterina*) *lucina* Walcott, p. 73, pl. 14, fig. 1.

Lingulella manchuricensis Walcott, p. 74, pl. 14, figs. 2, 2a.

Lingulella marcia Walcott, p. 74, pl. 14, figs. 3, 3a.

- Acrotreta venia* Walcott, p. 75, pl. 14, figs. 4, 4a.
Orithotheca glabra Walcott, p. 75, pl. 14, figs. 5, 5a.
Albertella pacifica Walcott, p. 76, pl. 14, fig. 6.
Stephanocare ? monkei Walcott, p. 77, pl. 14, fig. 7.
Ptychoparia granosa Walcott, p. 77, pl. 14, fig. 8.
Ptychoparia (Emmrichella) theano (Walcott), p. 79, pl. 14, figs. 9, 9a.
Ptychoparia kochibeii Walcott, p. 78, pl. 14, figs. 10, 10a.
Crepicephalus convexus Walcott, p. 79, pl. 14, figs. 11, 11a.
Pteroccephalus ? liches Walcott, p. 80, pl. 14, fig. 12.
Inouyia capax (Walcott), p. 80, pl. 14, fig. 13.
Inouyia ? thisbe Walcott, p. 81, pl. 14, fig. 14.
Agraulos sorge Walcott, p. 82, pl. 15, fig. 1.
Lisania bura (Walcott), p. 82, pl. 15, fig. 2.
Chuangia botia (Walcott), p. 84, pl. 15, figs. 3, 3a.
Chuangia fragmenta Walcott, p. 84, pl. 15, fig. 4.
Chuangia nais Walcott, p. 84, pl. 15, fig. 5.
Chuangia nitida Walcott, p. 85, pl. 15, fig. 6.
Levisia agenor (Walcott), p. 86, pl. 15, fig. 7.
Anomocare ephori Walcott, p. 90, pl. 15, figs. 8, 8a.
Anomocare lisani Walcott, p. 90, pl. 15, figs. 9, 9a-b.
Anomocarella hermius Walcott, p. 92, pl. 15, fig. 10.
Anomocarella macar Walcott, p. 92, pl. 15, figs. 11, 11a-b.
Coosia superba Walcott, p. 94, pl. 16, figs. 1, 1a.
Coosia robusta Walcott, p. 97, pl. 16, figs. 2, 2a.
Asaphiscus iddingsi Walcott, p. 99, pl. 16, fig. 3.
Bathyriscus manchuriensis Walcott, p. 97, pl. 16, fig. 4.
Solenopleura chalcon Walcott, p. 83, pl. 16, fig. 5.
Anomocare laeve Angelin, p. 87, pl. 17, figs. 1, 1a-c.
Anomocare convexa Walcott, p. 87, pl. 17, figs. 2, 2a-d.
Anomocarella smithi Walcott, p. 92, pl. 17, figs. 3, 3a.
Levisia richardsoni Walcott, p. 86, pl. 17, figs. 4, 4a.
Levisia nasuta Walcott, p. 87, text figs. 7, 7a; pl. 17, fig. 5.

The memoir on the Cambrian faunas of China is now well advanced and will probably be printed and distributed the latter part of the year 1911.

BRACHIOPODA

MICROMITRA (PATERINA) LUCINA, new species

Plate 14, fig. 1

Ventral valve, depressed subconical, with a minute beak curving over and concealing the pseudo-deltidium. The cardinal slope is bent abruptly backward and downward so as to form a narrow false area on each side of a wide, open, triangular space.

Dorsal valve transverse, gently convex, with the nearly straight posterior margin shorter than the greatest width of the valve; beak minute, marginal; false area unknown.

Surface marked by concentric, slightly irregular, rounded lines and ridges of growth that may or may not be grouped in bands of

varying width. A dorsal valve shows a few fine, faint, radiating ridges.

A ventral valve 3 mm. in width has a length of 2.75 mm. and a height of 1 mm. A dorsal valve with a width of 2.5 mm. has a length of 2 mm. and a height of 0.5 mm. at the beak.

Observations.—In form the ventral valve of this species is not unlike that of *Micromitra sculptilis* (Meek) except that it is not as elevated and its surface is quite different. It is associated with *M. sculptilis* and the two varieties of *Micromitra* (*Iphidella*) *pannula*,—*ophirensis* and *maladensis*.

Formation and locality.—Middle Cambrian: Fu-chóu series; (35u and 35r) limestones and (36d) shales near the base just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

LINGULELLA MANCHURIENSIS, new species

Plate 14, figs. 2, 2a

This species and *Lingulella marcia* belong to a group of small, elongate, oval shells that are represented in the Rocky Mountain Province Cambrian fauna by *Lingulella manticula* (White) and in the Atlantic Province fauna by *L. atava* (Matthew), *L. collicia* (Matthew), *L. ferruginea* (Salter), *L. nanno* (Walcott), and a number of similar forms. *Lingulella manchuriensis* appears to be most nearly related to *L. similis* (Walcott). It differs in the broader, more rounded posterior half of the ventral valve.

The average length of the ventral valve is 3 mm. among the large number of shells that occur in both limestone and shale.

Formation and locality.—Middle Cambrian: (35p) Fu-chóu series; shales about 80 feet (24 m.) above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

LINGULELLA MARCIA, new species

Plate 1, figs. 3, 3a

This species is one of the small forms allied to the group of similar shells mentioned under *L. manchuriensis*. It differs from the latter species in being relatively broader in outline, with the sides of the valves less uniformly arched, and in having a more broadly rounded frontal margin.

Interiors of the ventral valve indicate that the area was relatively shorter than that of *L. similis* (Walcott). Most of the shells in the limestone are less than 2 mm. in length; a few ventral valves in the shale are 3 to 5 mm. long.

Formation and locality.—Middle Cambrian: (35q and 36h) Fu-chón series; about 200 feet (61 m.) above the white quartzite; also in shales about 130 feet (40 m.) above the white quartzite; collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

A form flattened in the shale of locality 36f, which is much higher, but in the same section as the locality represented by *L. marcia*, has the outline of the latter species and is tentatively referred to it. This gives an extended stratigraphic range for the species, but not so great as that of *L. similis* (Walcott) which occurs in both the Middle and Upper Cambrian.

ACROTRETA VENIA, new species

Plate 14, figs. 4, 4a

Acrotreta venia is closely related to *A. shantungensis* Walcott. It differs in having a slightly less elevated ventral valve and a more distinct and broader flattening of the posterior side and margin. The faintly defined false area and apex of the valve curve slightly over the posterior margin. The dorsal valve does not show the median depression of the dorsal valve of *A. shantungensis*. Of the American Pacific Province species of *Acrotreta*, it most nearly approaches *A. idahoensis* (Walcott) in the external form of the valves. The vascular markings on the interior of the dorsal valve differ in detail as may be seen by comparing them.

Formation and locality.—Middle Cambrian: (35q) Fu-chón series; about 200 feet (61 m.) above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

ORTHOTHECA GLABRA, new species

Plate 14, figs. 5, 5a

Form an elongate, slender, rounded tube, with the dorsal face less convex than the sides and ventral face. Transverse section round,

except for the slightly flattened dorsal side. Operculum unknown. Shell rather thick, and with a smooth surface.

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

Observations.—This species is distinguished from other Chinese forms by its rounded tube and smooth surface. It is the representative in form of the American *Orthotheca communis* Billings.¹

Orthotheca glabra occurs abundantly in association with *Hyalithes cybele* Walcott, in the *Dorypyge richthofeni* zone of Manchuria. Some of the shells have a long, slender terminal section to the tube that is more or less slightly curved. It is so slender and round that it suggests the tube of *Hyalithellus*.²

Formation and locality.—Middle Cambrian: (C71) massive cliff making limestone in the central portion of the Ki-chóu formation, 4 miles (6.4 km.) southwest of Tung-yü; and (C72) thin green gray limestone interbedded with ocherous and green clay shales, overlying the massive oolite in the Ki-chóu formation, 4 miles (6.4 km.) east of Fang-lan-chön; both in Shan-si, China.

Collected by Eliot Blackwelder.

Also (35n) Middle Cambrian: Fu-chóu series; limestones near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

ALBERTELLA PACIFICA, new species

Plate 14, fig. 6

Of this form only one fragment of the pygidium was found in the collection from Manchuria. This is so characteristic that I do not hesitate to identify it as the pygidium of an *Albertella* although stratigraphically it occurs at a higher horizon in the Middle Cambrian than the American species of the genus.

A pygidium illustrated by M. Barrande as *Paradoxides desideratus* Barrande³ may possibly belong to a species of *Albertella*. The axial lobe of the pygidium has seven rings and a terminal section and the pleural lobes have lateral spines.

Formation and locality.—Middle Cambrian: (36f) Fu-chóu series; about 1000 feet (305 m.) above the white quartzite, collected in a

¹ Tenth Ann. Rept. U. S. Geol. Survey, 1891, pl. 77, figs. 3, 3a-g.

² Idem, pl. 79, fig. 1a.

³ Barrande, 1852, Système Silurien du Centre de la Bohême, Vol. 1, pl. 12, fig. 15.

low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

STEPHANOCARE ? MONKEI, new species

Plate 14, fig. 7

Stephanocare sp. MONKE, 1903, Jahrb. König. Preuss. Geol. Landesanst. und Bergakad., Vol. 23, Pt. 1, p. 144, pl. 8, figs. 1, 1a, 2-4. (Described and discussed.)

Doctor Monke doubtfully refers a cephalon, two pygidia, and a free cheek to *Stephanocare*. Similar pygidia occur on the platy limestones collected by Mr. Blackwelder and as they are clearly distinct from any described species I give them the specific name of *S. ? monkei* in recognition of the most excellent work done by Doctor Monke on this interesting fauna. The generic reference is in doubt as we have no entire specimens of *Stephanocare richthofeni* Monke and of this species for comparison.

Formation and locality.—Middle Cambrian: (C6) thin slabby limestone in the upper shale member of the Kiu-lung group, 2.5 miles (4 km.) southwest of Yen-chuang, Sin-t'ai District, Shan-tung, China.

Collected by Eliot Blackwelder.

PTYCHOPARIA GRANOSA, new species

Plate 14, fig. 8

Ptychoparia granulosa WALCOTT, 1905, Proc. U. S. National Museum, Vol. 29, p. 78. (Species described as below. This species is believed to be congeneric with Hall and Whitfield's species; since the name *granulosa* is therefore preoccupied for *Ptychoparia*, *granosa* is proposed.)

Not *Crepicephalus* (*Loganellus*) *granulosus* HALL and WHITFIELD, 1877, Geol. Expl. Fortieth Parallel, Vol. 4, p. 214, pl. 2, figs. 2, 3.

The gently convex central portions of the cephalon, exclusive of the free cheeks, are all that is known of this species. These indicate a rather broad, semicircular cephalon, with small free cheeks, wide fixed cheeks, narrow, short, convex glabella, and narrow, flattened frontal rim; glabella marked by three pairs of faintly impressed but clear glabella furrows; frontal space between the glabella and rim broader than the frontal rim and slightly convex; palpebral ridge narrow, clearly defined, and merging into a rather small eye lobe.

Surface finely granulose.

Formation and locality.—Lower Cambrian: (C17) ferruginous limestone nodules in the brown sandy shales at the top of the Man-t'ò shale, at Ch'ang-hia, Shan-tung, China.

Collected by Eliot Blackwelder.

PTYCHOPARIA KOCHIBEI, new species

Plate 14, figs. 10, 10a

The cephalon of *P. kochibei*, in outline, wide fixed cheeks, broad frontal limb, and broadly rounded front margin of the gabella, is similar to the cephalon of *Ptychoparia granosa* Walcott (pl. 14, fig. 8). It differs in having a more pronounced swelling of the frontal limb in front of the glabella, more tumid fixed cheeks, and in surface characters. The surface of *P. granosa* is thickly studded with minute tubercles, while that of *P. kochibei* is smooth or possibly finely punctate; its frontal limb is also marked by fine, irregular, sometimes inosculating, rounded ridges that extend from in front of the glabella and palpebral ridges to the groove within the flattened frontal rim (pl. 14, fig. 10a).

The thorax has fourteen transverse segments with a narrow axial lobe and wide pleural lobes. The pleural furrow starts on the inner front side of the pleural lobe of each segment and, widening nearly to the width of the segment, begins to narrow at the point of geniculation and terminates near the posterior margin at the somewhat abrupt falcate termination of the pleura.

Pygidium small; the axial lobe is crossed by two furrows that serve to outline two transverse rings and a terminal section; two anchylosed segments are outlined on the pleural lobes on each side of the axial lobe by furrows that curve gently backward toward the faintly defined border.

Surface finely punctate or slightly roughened by minute depressions.

Observations.—This is the only Chinese species of *Ptychoparia* of which we have the entire dorsal shield; all the other species are represented by the separated parts. In outline the dorsal shield is not unlike that of *Ptychoparia kingi* (Meek),¹ and it may be considered as the Chinese representative of that species.

The specific name is given in honor of the former Director of the Geological Survey of Japan, Doctor Kochibe.

Formation and locality.—Middle Cambrian: (35n, 35r, and 36e) Fu-chóu series; limestones and shales interbedded with limestones.

¹ Walcott, 1886, Bull. U. S. Geol. Survey, No. 30, p. 193.

near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

EMMRICHELLA, new subgenus of **PTYCHOPARIA**

This subgenus differs from *Ptychoparia* in its smooth glabella and larger palpebral lobe; from *Liostracus*, in having an arched or nearly flat frontal limb and rim and more convex cranidium; from *Conocephalina*, in its smoother glabella and wider fixed cheeks; and from *Anomocare*, in its smoother glabella, usual absence of distinct palpebral ridge, proportionately shorter eye lobes, and glabella.

Genotype.—*Ptychoparia theano* Walcott.¹ (pl. 14, figs. 9, 9a.)

Observations.—This subgenus is characterized by a nearly smooth surface on the glabella and fixed cheeks, rather large palpebral lobes, and narrow postero-lateral limbs. Unfortunately, no entire specimens of the cephalon and thorax are known, and the pygidia referred to it may or may not belong to the species to which they are tentatively assigned. Only when a thorough study is made of all the material within the Conocephalinæ will it be possible to make even a fairly adequate grouping of the species.

Of the species of this subgenus from China, *P. (E.) theano* (Walcott), *P. (E.) bromus* (Walcott), and *P. (E.) eriopia* (Walcott) have the posterior, elongate palpebral lobe. In *P. (E.) mantoensis* (Walcott) and *P. (E.) constricta* (Walcott) the palpebral lobe is much like that of *Ptychoparia* in its position.

Stratigraphic range.—*Ptychoparia (Emmrichella) mantoensis* and *P. (E.) constricta* occur at the summit of the Lower Cambrian; *P. (E.) eriopia* and *P. (E.) theano*, at the base of the Ch'ang-hia formation of the Middle Cambrian; and *P. (E.) bromus*, at about the same horizon in the Kiu-lung formation.

CREPICEPHALUS CONVEXUS, new species

Plate 14, figs. 11, 11a

The cranidium of this species differs from that of *C. damia* (Walcott) in its shorter frontal lobe, flatter frontal rim, and proportionately longer glabella. The associated pygidium has a proportionately shorter axial lobe and its sides curve outward instead of inward.

Formation and locality.—Middle Cambrian: (35r) Fu-chóu series; limestones near the base of the series just above the white quartzite,

¹ Walcott, 1905, Proc. U. S. Nat. Mus., Vol. 29, p. 82.

collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

PTEROCEPHALUS ? LICHES, new species

Plate 14, fig. 12

This species is represented by four specimens of the pygidium. It is quite unlike the pygidium referred to *P. busiris* Walcott and with the discovery of entire specimens of the dorsal shield it may be found that the generic reference is incorrect.

The pygidia average 4 mm. in length and are finely preserved in the compact limestone matrix.

Formation and locality.—Middle Cambrian: (35n) Fu-chóu series; limestones near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

Genus INOUYIA, new genus

The species referred to this genus are represented only by the cranidium. This in the genotype has a swollen, tumid frontal limb, small palpebral lobes, a convex and more or less subrectangular glabella, strong dorsal furrows about the glabella, and clearly marked glabellar furrows.

Surface apparently smooth, but with a strong lens it has a slightly roughened appearance caused by a shallow, irregular pitting.

Genotype.—*Agraulos ? capax* Walcott¹ (pl. 14, fig. 13).

The swollen frontal limb, small palpebral lobes, and convex glabella at once suggest *Agraulos* (see pl. 15) and in fact all of the species now referred to *Inouyia* with the exception of *I. titiana* (Walcott) were at first referred to *Agraulos*. My reasons for separating them and creating the genus *Inouyia* are that the tumidity of the frontal limb is so pronounced as to become a marked feature and the glabella is more rectangular in the typical species. To these should be added the general effect of the cranidium when compared directly with the cranidium of *Agraulos ceticephalus* (Barrande).² I think it quite probable that when entire specimens of the dorsal

¹Walcott, 1906, Proc. U. S. Nat. Mus., Vol. 30, p. 580.

²Système Silurien du Centre de la Bohême, Vol. 1, 1852, pl. 10, figs. 1-21. Barrande referred the species to the genus *Arionellus*, a synonym of *Agraulos*.

shield of the various species are available for comparison other differences will be found to exist between *Inouyia* and *Agraulos*.

In grouping the Chinese species under *Inouyia* some are found to be close to *Agraulos*, notably *I. abaris* (Walcott), *I. acalle* (Walcott), and *I. regularis* (Walcott), and it is probable that with more complete specimens of the species they will be referred to a subgenus intermediate between *Inouyia* and *Agraulos*.

The wide fixed cheeks of *Inouyia capax* are confined to this species, as all other species referred to *Inouyia* have relatively narrow fixed cheeks. The large eye of *I. ? inflata* (Walcott) and relatively narrow frontal limb serve to place it apart from the other species.

I am not at all satisfied with the arrangement of species under *Inouyia* but in dealing with such fragmentary specimens much must be left to future discovery and closer work.

Attention is also called to *Ellipsocephalus hoffi* Barrande¹ as in that species the frontal limb is convex and the glabella subrectangular.

The generic name is given in recognition of Dr. Kinoshita Inouye, Director of the Imperial Geological Survey of Japan.

INOUYIA ? THISBE, new species

Plate 14, fig. 14

This species is represented by two broken specimens of the cranidium. These show that the glabella is much like that of *Inouyia titiana* (Walcott), also the fixed cheeks and palpebral lobes. It differs in the transverse swelling of the frontal limb. In *I. ? thisbe* the frontal limb rises with a slight slope in front of the glabella, and curves gently downward to the margin without a trace of a frontal border as in *Inouyia inflata* (Walcott). In *I. titiana* the frontal limb is abruptly convex and there is an almost flattened border.

The surface of *I. ? thisbe* is distinctly punctate and in this respect resembles *Agraulos dryas*.

The type specimen of the cranidium has a length of 5.5 mm.

Formation and locality.—Middle Cambrian: (C28) thin bedded oolitic limestone at the base of the Ch'ang-hia limestone, just above the shales in the face of the cliff one mile (1.6 km.) east-southeast of Ch'ang-hia, Shan-tung, China.

Collected by Eliot Blackwelder.

¹ Barrande, 1852, *Système Silurien du Centre de la Bohême*, Vol. 1, pl. 10, figs. 26, 27.

AGRAULOS SORGE, new species

Plate 15, fig. 1

This species is represented by a single specimen of the central portions of the cephalon. Among the Chinese species referred to *Agraulos* it may be compared with *A. dryas* Walcott, from which it is readily distinguished by its broader, less convex glabella and its almost smooth, instead of strongly punctate, surface.

Agraulos sorge appears to have had a strong occipital spine that projected upward and backward from the occipital ring; only the base of the spine is preserved.

Surface slightly roughened by a minute, irregular, shallow pitting.

Formation and locality.—Middle Cambrian: (35n) Fu-chôu series; limestones near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by Eliot Blackwelder.

Genus LISANIA, new genus

Cranidium subquadrate in outline, exclusive of postero-lateral limbs. Glabella with slightly converging sides, broadly rounded in front and curving gently down to a narrow furrow separating it from the frontal border, without distinctly marked glabellar furrows; occipital furrow distinct; occipital segment strong. Fixed cheeks narrow; palpebral lobe above the eye nearly one-third the length of the cephalon; palpebral ridge usually defined to the edge of the dorsal furrow beside the glabella. Frontal border slightly convex and separated from the fixed cheeks and glabella by a narrow, shallow but distinct furrow.

The associated free cheeks have a strong genal spine, and associated pygidia a strong central axis marked by three or four transverse rings and a terminal section.

Surface smooth or slightly roughened by very fine shallow pits.

Genotype.—*Anomocarella bura* Walcott¹ (pl. 15, fig. 2).

Observations.—This genus is founded to receive four species that do not appear to fall within any described genus. From *Pagodia* it differs in having a longer eye lobe, narrower free cheeks, flatter frontal margin. *Pagodia* occurs with the Upper Cambrian fauna, *Lisania* with the Middle Cambrian fauna. From *Chuangia* (pl. 15, figs. 3-6) it differs in its narrower frontal border, narrower fixed

¹ Walcott, 1905, Proc. U. S. Nat. Mus., Vol. 29, p. 56.

cheeks, and quite unlike associated pygidium. The three genera, *Lisania*, *Pagodia*, and *Chuangia*, all have a strong, nearly smooth glabella and a narrow frontal margin and do not appear to come within the limits of *Agraulos*, *Anomocare*, *Ptychoparia*, *Coosia*, or *Solenopleura*.

The species referred to the genus are all small and unfortunately only represented by cranidia and associated free cheeks and pygidia. It may be that when entire specimens of the dorsal shield are found other marked differences will appear between the three genera, *Lisania*, *Pagodia*, and *Chuangia*.

The generic name is taken from Li San, the Chinese assistant of both Dr. Bailey Willis and Dr. Joseph P. Iddings.

The species referred to the genus *Lisania* are:

- L. agonius* (Walcott), Kiu-lung group, Middle Cambrian.
- L. ajar* (Walcott), Kiu-lung group, Middle Cambrian.
- L. alala* (Walcott), Ch'ang-hia limestone, Middle Cambrian.
- L. ? belemus* (Walcott), Ch'ang-hia limestone, Middle Cambrian.
- L. bura* (Walcott), Ch'ang-hia limestone, Middle Cambrian.
- L. cf. bura* (Walcott), Ch'ang-hia limestone, Middle Cambrian.

SOLENOPLEURA CHALCON, new species

Plate 16, fig. 5

Only one specimen of the cranidium of this species is known. In form it is nearest to *Solenopleura bcroc* Walcott. It differs in having a proportionately narrower glabella, more convex free cheeks, more rounded frontal rim, and in the presence of a depression dividing the frontal limb on the median line of the glabella. Its tuberculated surface is much like that of *S. bcroc*.

Formation and locality.—Middle Cambrian: (35r) Fu-chóu series; limestones near the base just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liao-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

Genus CHUANGIA, new genus

This genus is proposed for a group of Upper Cambrian trilobites in which the cephalon has a truncato-conical or subquadrangular glabella; a narrow, concave frontal limb; and, so far as known, a smooth test.

The associated pygidium is large, with a strong axis, broad pleural lobes, and few indications of segments.

The general form of the glabella is much like that of some species of *Anomocare* (pl. 17) but the frontal limb is quite different. The latter suggests *Pagodia lotos* Walcott but the frontal limb of the latter is absorbed by the rounded frontal rim. In *Chuangia* the frontal limb and rim meet to form an angle and the rim does not rise above the upward sloping surface of the frontal limb.

Genotype.—*Chuangia batia* Walcott¹ (pl. 15, figs. 3, 3a). Three other species are known from the Upper Cambrian formations of China: *Chuangia nitida*, *C. nais*, and *C. fragmenta*.

CHUANGIA FRAGMENTA, new species

Plate 15, fig. 4

Only a fragment of the cephalon of this species is known. This suggests the glabella of *Chuangia batia*, but the narrow fixed cheeks serve to distinguish it. The surface is smooth to the unaided eye, and slightly pitted or punctate under a strong lens. The fragment of the cephalon has a length of 16 mm.

Formation and locality.—Upper Cambrian: (C61) a dense black limestone in the uppermost limestone member of the Kiu-lung group, 3 miles (4.8 km.) southwest of Yen-chuang, Sin-t'ai District, Shantung, China.

Collected by Li San.

CHUANGIA NAIS, new species

Plate 15, fig. 5

This is a large species that is represented by a part of the central portions of the cephalon. Glabella subquadrangular, moderately convex, narrowing slightly toward its broadly rounded front; without glabellar furrows so far as can be determined; occipital furrow shallow, rather broad, and nearly transverse; occipital ring gently convex, and slightly wider toward the center; dorsal furrow shallow and clearly defined.

Fixed cheeks about two-thirds the width of the glabella, nearly flat between the glabella and the palpebral lobes, and sloping downward in front to the frontal rim, and back to the posterior furrow:

¹Walcott, 1905, Proc. U. S. Nat. Mus., Vol. 29, p. 75.

palpebral lobe small; palpebral ridge narrow, low, and situated so as to cross the fixed cheek obliquely where the downward slope to the front is most marked; postero-lateral limbs long, with a strong furrow within the strong rounded rim; the front of the glabella passes into the broad groove that merges into the upward sloping, narrow frontal limb; frontal rim rounded and marked by rather strong striae parallel to the front border.

Surface smooth to the unaided eye; a strong lens shows a slight, irregular pitting where the outer surface is intact. The type specimen of the cephalon has a length of 20 mm.

Observations.—This species was at first confused with *Chuangia batia*. It differs from the latter in the form of the glabella, and the size of the palpebral lobes and frontal limb. The same features distinguish it from *Chuangia nitida* and *C. fragmenta*.

Formation and locality.—Upper Cambrian: (C64) upper limestone member of the Kiu-lung group, 2.7 miles (4.3 km.) southwest of Yen-chuang, Sin-t'ai District, Shan-tung, China.

Collected by Eliot Blackwelder.

CHUANGIA NITIDA, new species

Plate 15, fig. 6

Only the central portions of the moderately convex cephalon of this species is known. Within the facial sutures the outline is subquadrangular, exclusive of the short postero-lateral limbs. Glabella slightly convex, truncato-conical, with a very slight trace of short, slightly oblique posterior glabellar furrows; the latter are shown more distinctly on the cast of the interior; occipital furrow shallow and clearly defined; occipital ring slightly convex and rather broad toward the center; dorsal furrow shallow at the sides of the glabella.

Fixed cheeks about one-half the width of the glabella, gently convex; palpebral ridges strong, low, and passing obliquely backward to the rim of a rather large palpebral lobe; the latter is a little longer than one-third the length of the cephalon. The frontal limb is represented by the short concave space in front of the glabella which forms a sharp angle in uniting with the frontal limb.

Surface slightly pitted when seen through a strong magnifying glass. Length of cephalon, 7 mm.

Observations.—This species is much smaller than the type species, *Chuangia batia*. It differs from the latter in its narrower frontal

limb, larger palpebral lobes, and more elongate glabella. From *Chuangia nais* and *C. fragmenta* it differs in its longer palpebral lobes and in the outline of the glabella.

Formation and locality.—Upper Cambrian: (C11) crystalline limestone 60 feet (18 m.) above the base of the uppermost limestone member, 2.1 miles (3.4 km.) southwest of Yen-chuang, Sin-t'ai District, Shan-tung, China.

Collected by Eliot Blackwelder.

Genus LEVISIA, new genus

This genus is proposed to include a group of small trilobites represented by *Agraulos agenor* Walcott.¹ The cranidium is strongly convex; glabella truncato-conical, tumid, and with only a trace of glabellar furrows; occipital ring narrow at the sides, broadening rapidly toward the center, convex, and extending backward into an obtuse spine. Frontal limb very narrow and passing almost without any line of demarcation into the rather broad, slightly convex frontal margin of the cephalon. Fixed cheeks tumid, about half as wide as the glabella and with small palpebral lobes midway of their length. Postero-lateral limbs rather short and marked by a deep, narrow, intermarginal posterior furrow that separates a narrow, rounded margin.

Genotype.—*Agraulos agenor* Walcott¹ (pl. 15, fig. 7). A second species, *Levisia adrastia* (Walcott)² has the same generic characters. Its surface has the same pitting and in addition a few relatively large, scattered granules.

LEVISIA RICHARDSONI, new species

Plate 17, figs. 4, 4a

Two species of this genus occur with an Upper Cambrian fauna in the boulders of the conglomerate at Point Lévis, opposite Quebec, Canada. The first I shall give the name of *Levisia richardsoni* in recognition of the fine collecting work done by Mr. J. Richardson under the direction of Sir William E. Logan.

¹ Walcott, 1905, Proc. U. S. Nat. Mus., Vol. 29, p. 44.

² Idem, p. 61.

LEVISIA NASUTA, new species

Plate 17, fig. 5 and text figs. 7 and 7a.

The second Canadian species associated with *Levisia richardsoni* is *Levisia nasuta*. The glabella of this species is very convex; fixed cheeks narrow and merging anteriorly into the bluntly pointed frontal limb and margin. A dorsal view of the cranidium is given on plate 17, figure 5, and the accompanying text figures show a front and side view of the specimen represented on plate 17.

*Levisia nasuta*, new species.

FIGS. 7, 7a.—Side and front views, $\times 10$. U. S. National Museum,
Catalogue No. 57600.

Genus ANOMOCARE Angelin

Anomocare ANGELIN, 1854, Palaeontologia Scandinavica, Edition of 1878,
p. 24.

For the purpose of comparison a cranidium, free cheek, and pygidium of *Anomocare laeve* are illustrated by figs. 1, 1a-c, pl. 17; also an entire dorsal shield of *Anomocare convexa*, new species (figs. 2, 2a-d, pl. 17), from the Middle Cambrian strata of Alabama.

Genotype.—*Anomocare laeve* Angelin (1854, edition of 1878, p. 25).

ANOMOCARE CONVEXA, new species

Plate 17, figs. 2, 2a-d

Dorsal shield large, elliptical in outline; axial lobe narrow and convex; cephalon semicircular in outline with the genal angles produced into spines. The facial sutures cut the posterior margin a short distance within the genal angles and extend inward with a slight curvature and forward to the base of the palpebral lobe; arch-

ing around the palpebral lobe, they extend downward and slightly forward a short distance and then with a broad sweep curve inward, cutting the anterior margin on a line with the outer edge of the palpebral lobe. Cranidium with a large glabella, concave frontal limb, relatively narrow fixed cheeks, and elongate, narrow postero-lateral limbs. Glabella moderately convex, with the sides gradually converging to its broadly rounded front margin; it is marked by four pairs of short furrows that penetrate obliquely inward and backward from the sides; the two posterior lobes outlined by the oblique furrows are roughly subtriangular in outline, the furrows penetrating nearly one-third of the distance toward the center. The second pair appears to be represented by rather prominent, slightly convex tubercles, and extends about one-fourth the distance across the glabella. Viewed with a transverse light, the second pair of lobes appears to be a forward extension of the posterior pair of lobes, since the furrows back of them are not quite so deep as the more oblique furrow just inside of the inner postero-lateral margin of the second pair of furrows; the third pair of lobes extends obliquely inward and backward about one-third of the distance across the glabella; the fourth pair is outlined posteriorly by a rather deep furrow that increases in width from the outer margin inward for a short distance so as to form a shallow, triangular area. The anterior margin of the fourth pair of glabellar lobes is just back of a pit which occurs on the side of the glabella opposite the inner end of the palpebral ridge. On very finely preserved specimens a narrow, gently arched ridge appears to represent the extension of the palpebral ridges on the fixed cheeks. There is also a transverse furrow just within the anterior margin of the glabella. The glabellar furrows and lobes described indicate that the glabella is formed by the union of five or possibly six of the original segments of one of the ancestral forms of this trilobite.¹ The occipital ring is separated from the glabella by a furrow that is rather broad and deep on each side, and narrow, shallow, and arching slightly forward across the center; occipital ring slightly convex, broad across the central portions, narrowing and terminating directly in the line of the posterior intermarginal furrow of the fixed cheeks. Fixed cheeks about half as wide as the glabella, nearly flat within the palpebral lobe and ridge, and sloping gently down into the postero-lateral limb. They are interrupted in front by the strong palpebral ridges which extend backward from a point opposite the anterior pair of glabellar furrows

¹ Walcott, Smithsonian Misc. Coll., Vol. 53, 1910, pp. 237-238.

and merge into the arched palpebral lobes; in front of the palpebral ridge the cheeks descend rapidly and merge into the frontal limb; the postero-lateral limb is long and almost entirely made up of the rounded, narrow posterior rim, strong intermarginal furrow, and a narrow area between the furrow and the facial suture. Palpebral lobe of medium length; in a cephalon 18 mm. in length it has a length of 4 mm.; it is narrow and raised a little above the surface of the fixed cheeks. Frontal limb broad and strongly concave in large cephalons, becoming less so in smaller; in front of the glabella it slopes rather rapidly downward and then upward with a gentle curve to the thin, rounded edge. Free cheeks gently convex, but become slightly concave toward the outer margin in the larger specimens. The genal angles are extended into short spines.

Thorax with eleven nearly transverse segments; axial lobe convex and a little more than one-half the width of the pleural lobes. It is strongly defined by a sharp angle where the segments pass into the pleural lobes. Each segment arches forward slightly at the center, also at the sides just before joining the pleural portion of the segment; the pleural lobe of each segment is transverse for about one-half its length, and then it curves gently down toward the falcate termination. The pleural grooves start just within the front rim of each segment next to the axial lobe, and, widening, continue with a nearly uniform width for about two-thirds of the distance outward, and then narrow, disappearing some little distance within the termination of the segment.

Pygidium large, moderately convex, with a narrow, strongly convex axial lobe and broad, slightly flattened margin; axial lobe five-sixths of the length of the pygidium, convex and narrowing gradually from the anterior margin to its termination; it is crossed by from five to six shallow, transverse furrows that outline from six to seven slightly convex rings and a terminal section; from the axial lobe the surface of the pleural lobes slopes at first gently and then quite rapidly down for about two-thirds of their width and then very gradually out to the margin. They are marked by five or six broad furrows and rather broad, flattened ridges that are the continuation on the pleural lobe of the transverse rings on the axial lobe; the posterior margin curves more or less inward toward the median line so as to give a more or less indented outline to the otherwise rounded curve of the sides and posterior margin of the pygidium.

Surface under a strong lens shows numerous pits or pores; the free cheeks and the cranidium in front of the glabella and palpebral

ridges are beautifully marked by irregular radiating ridges that branch quite irregularly and are united by irregular cross-ridges so as to give an anastomosing effect.

Dimensions.—The dimensions are shown by the figures on pl. 17, figs. 2 and 2a.

Observations.—The cranidium of this species is much like that of *Anomocare laevis* (pl. 17, fig. 1). Each has a broad, more or less concave frontal limb and margin marked by radiating ridges, large eyes, and an elongate glabella marked by five short lobes on each side.

The pygidium in each species is of the same type and the surface has the same punctate character in each.

Anomocare convexa is associated with several other species of *Anomocare*.

Formation and locality.—Middle Cambrian: (90x) Conasauga formation; in and attached to the outer surface of siliceous nodules in argillaceous shales, Coosa Valley, east of Center, Cherokee County, Alabama.

Collected by A. M. Gibson, 1884; and Cooper Curtice, 1885.

ANOMOCARE EPHORI, new species

Plate 15, figs. 8, 8a

This species is represented by specimens of the cranidium and associated pygidia that are referred to it. It is closely related to *Anomocare flava* Walcott. It differs in details of frontal limb and border, glabella, and fixed cheeks. It has a less deeply impressed line between the frontal limb and border than that of *A. flava*.

Formation and locality.—Middle Cambrian: (35r) Fu-chou series; limestones near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

ANOMOCARE LISANI, new species

Plate 15, figs. 9, 9a-b

This fine species is represented by numerous specimens of fragments of the cephalon, segments of the thorax, and entire pygidia. They are all compressed in a fine, argillaceous shale and usually only a faint impression remains. The cranidium is not unlike that of

Coosia limbatum (Angelin); it differs in having a slightly convex or rounded frontal limb and proportionately narrower glabella. The pygidium is quite different in outline; the rounded indented posterior margin of *A. limbatum* is represented by a deep notch that gives a bilobed appearance to the very broad margin; the axial lobe is also longer and broader than that of *A. limbatum*. The doublure of the pygidium extends close up to the termination of the furrows of the pleural lobe. The pleural lobes of the thoracic segments have a narrow, strong furrow that extends from the inner, anterior margin diagonally across nearly to the posterior margin of the backward curving, slightly falcate ends of the segment.

The stratigraphic position of this species is about 250 feet (79 m.) above the zone of *Anomocare latelimbatum* Angelin.

The specific name is given in recognition of the excellent work done by Li San, who assisted Professors Willis and Iddings in their collecting.

Formation and locality.—Middle Cambrian: (35q) Fu-chón series; about 200 feet (61 m.) above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

Genus ANOMOCARELLA Walcott

Anomocarella WALCOTT, 1905, Proc. U. S. National Museum, Vol. 29, p. 54.
(Genus characterized.)

Anomocarella was proposed to include species from the Middle Cambrian of China, that differ from *Anomocare* in the absence of glabellar furrows and the presence of a relatively narrow, flattened frontal rim. The sides of the glabella are parallel, palpebral lobes of medium size, and palpebral ridges more or less clearly defined. The associated pygidium has a narrow, conical axis, marked by several transverse furrows which extend out on the pleural lobes and more faintly on the sloping rim.

Genotype.—*Anomocarella chinensis* Walcott.

Observations.—The type of this genus has ten segments in the thorax with a broad pleural furrow that starts near the inner anterior margin of a segment, broadens very rapidly and extends out beyond the geniculation before gradually narrowing to a point. In *Anomocarella smithi* (pl. 17, figs. 3, 3a) there are twelve segments in the thorax with the same type of pleural furrow.

ANOMOCARELLA HERMIAS, new species

Plate 15, fig. 10

This species is represented by specimens of the cranidium that have an unusually large and long palpebral lobe. This character is sufficient to distinguish it from other described species. The surface appears to be minutely punctate or marked by minute, shallow pits.

Formation and locality.—Middle Cambrian: (35n) Fu-chóu series; limestones near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

ANOMOCARELLA MACAR, new species

Plate 15, figs. 11, 11a-b

Of the Chinese species of *Anomocarella*, the cranidium of this species may be compared with that of *A. tatian* (Walcott) in that the frontal limb curves more abruptly down toward the frontal margin than in most species of the genus, and the frontal margin also bends downward to a greater degree. The outline of the glabella and fixed cheeks is almost similar in the two species. The associated pygidia are more elongate than those referred to *A. tatian* and have a greater number of segments in the axial and pleural lobes.

Formation and locality.—Middle Cambrian: (35n) Fu-chóu series; limestones near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

ANOMOCARELLA SMITHI, new species

Plate 17, figs. 3, 3a

Dorsal shield of medium size, elongate-elliptical in outline, convex, with the axial lobe strongly defined and convex. Cephalon semi-circular in outline, with the genal angles extended into short, sharp spines; a narrow, flattened border extends across the front of the cranidium and continues along the free cheeks until it passes into the genal spines; the posterior margin is narrow and distinctly defined by a strong, rounded furrow that terminates in the dorsal furrow beside the glabella. Cranidium with the front broadly rounded, narrow fixed cheeks, small antero-lateral limbs, and narrow

postero-lateral limbs, the greater part of which is taken up by the strong intermarginal furrow. Glabella without traces of transverse furrows except a short, slight indentation indicating a posterior pair of furrows; the glabella is separated from the fixed cheeks by a very narrow, strong dorsal furrow; the frontal limb is about the same width as the frontal margin, and extends almost directly downward from the dorsal furrow in front of the glabella to the sharp angle made by its union with the frontal margin; fixed cheeks about one-third the width of the glabella opposite the palpebral lobes, gently convex, and merging into the anterior and posterior limbs; occipital ring separated from the glabella by a strong rounded furrow, it is convex, broad along the center portions, and narrow toward the dorsal furrow. Palpebral lobe small, elevated, and about one-fourth the length of the cephalon; a low ridge extends from its anterior end forward and inward to the dorsal furrow beside the glabella. Free cheeks small, gently convex, and bordered by a flattened rim that is continued posteriorly into a spine; they are separated from the cranidium by the facial sutures which cut the posterior margin a short distance within the genal angles and extend with a slight sigmoid curve inward and forward to the base of the palpebral lobes; curving around these they extend with a slight outward curvature to the angle formed by the union of the frontal limb and margin, and then curve slightly inward across the margin.

Thorax with twelve rather narrow, nearly transverse segments; axial lobe convex, with the segments slightly rounded and separated from the pleural lobes by the obtuse angle formed by the union of the two lobes; pleural lobes a little wider than the axial lobe and flattened for about half their width, or to the geniculation, where each segment curves downward and slightly backward; pleural furrow relatively broad; it starts near the inner anterior edge of the pleural segment and extends along the center of the segment to the geniculation, where it gradually narrows to a point near the end of the flattened falcate termination of the segment.

Pygidium small; the subconical convex axis is marked by three shallow transverse furrows that outline three rings, and a terminal section that terminates within a short distance of the posterior margin of the pygidium; pleural lobes marked by the extension of the transverse furrows on the axial lobe and the faintly indicated, rather narrow border.

Surface slightly roughened by shallow pits or a network of very minute, irregular ridges, the interspaces of which give a pitted appearance.

Dimensions.—There are nine entire specimens of the dorsal shield exclusive of the free cheeks. The average length is 15 mm. The different parts have the following dimensions:

<i>Cephalon:</i>	mm.
Length	6.5
Width at posterior margin.....	9
Length of glabella and occipital ring.....	5
Width of glabella at base.....	3.5
<i>Thorax:</i>	
Length	7.5
Width at first segment.....	8
Width at last segment.....	5
<i>Pygidium:</i>	
Length	2
Width at anterior margin.....	4.5

Observations.—This species is the only one of the genus *Anomocarella* of which we have specimens showing the cephalon, thorax, and pygidium, with the exception of the compressed dorsal shield of *Anomocarella chinensis*. The cranidium differs from that of the type of the genus, *A. chinensis*, in having a relatively smaller palpebral lobe, and twelve segments, instead of eight, in the thorax.

Formation and locality.—Middle Cambrian; (90x) Conasauga formation; in and attached to the outer surface of siliceous nodules in argillaceous shales, Coosa Valley, east of Center, Cherokee County, Alabama.

Collected by A. M. Gibson, 1884; and Cooper Curtice, 1885.

Genus COOSIA, new genus

The description of the genotype *Coosia superba* and the observations accompanying it may be taken as the description and discussion of the genus.

Genotype.—*Coosia superba* Walcott.

COOSIA SUPERBA, new species

Plate 16, figs. 1, 1a

Dorsal shield large, elongate-elliptical in outline; axial lobe of medium width, conical, and narrowing from the cephalon gradually to the middle of the pygidium where it disappears.

Cephalon semicircular in outline, moderately convex, genal angles unknown. The facial sutures cut the posterior margin some distance within the outer margin and extend inward and forward with a slight sigmoid flexure to the base of the palpebral lobe; arching about

this they extend downward and with a gentle outward curve across the frontal limb and then curve inward across the broad frontal margin. Cranidium with a rather large, subconical, moderately convex glabella that shows very slight traces of lateral furrows. Occipital ring separated from the glabella by a furrow that is rather shallow and nearly transverse; occipital ring slightly convex and of nearly uniform width. Fixed cheeks narrow, about one-fourth or less of the width of the glabella; posteriorly they merge into the large subtriangular postero-lateral limbs which are marked by a shallow, intermarginal posterior furrow; anteriorly the fixed cheeks pass gently down and merge into the frontal limb. Palpebral lobe small, less than one-fifth the length of the cephalon; it is continued in a low ridge diagonally across the fixed cheek to the antero-lateral margin of the glabella. Frontal limb less than one-half the width of the broad, gently convex, frontal border; in front of the glabella it slopes gently downward to a shallow furrow that serves to distinguish it from the frontal border. Free cheeks unknown.

Thorax with twelve rather narrow, slightly convex segments with pleural lobes that arch slightly backward; axial lobe of each segment moderately convex and unmarked, so far as known, by any tubercles or spines; at a clearly defined dorsal furrow it unites with the pleural lobe which is about one-third wider than the axial lobe; the pleural furrows originate at the anterior inner side of the pleural segment and extend outward subparallel to the anterior margin about one-half the length of the pleural portion of the segment; the deepest portion of the furrow is just within the narrow anterior border which is about one-fourth the width of the segment; the exterior half of the segment is gently convex and terminates in a rather bluntly rounded end which may possibly be continued backward as a very short spine or point.

Pygidium large, moderately convex, with a short, convex axial lobe and very broad, campanulate margin; axial lobe about one-half the length of the pygidium, marked by two shallow, transverse furrows that are continued out on the gentle downward slope of the pleural lobes, outlining two segments marked by short, shallow, narrow furrows; the outer portions of the pleural lobes are nearly flat or rising slightly toward the postero-lateral margins; the semi-circular outline of the pygidium is interrupted toward the median axis by a slight inward curvature.

Surface slightly roughened, but not pitted or punctate so far as can be determined. The outer half of each pleura is marked by

imbricating lines subparallel to the margins of the pleura. Similar lines also occur on the flattened border subparallel to the margin of the pygidium.

Dimensions.—The dimensions are as shown by figure 1 of plate 16.

Observations.—This fine species represents a small group of species that occur in the Cambrian rocks of northern Alabama in the United States and in the Middle Cambrian rocks of the province of Shan-tung, China. The cephalon is not unlike that of *Anomocare* and *Anomocarella*. It differs from the former in having small palpebral lobes and a broad, slightly convex frontal border, and from the latter in the character of its frontal border. The thoracic segments of *Coosia* are unlike those of both of the two genera mentioned in having short, slightly marked, pleural furrows. The pygidium of *Anomocarella* is quite unlike that of *Coosia*; but the pygidium of *Anomocare* has the broad, flattened margin seen in *Coosia superba*.

Of the Chinese species referred to *Coosia*, *C. carme* (Walcott)¹ appears to be the most nearly related. *Coosia decelus* (Walcott)¹ has a somewhat similar frontal limb and border. Unfortunately the palpebral lobes and posterior portions of the cranium are unknown. *Coosia bianos* (Walcott)¹ has a somewhat similar frontal limb, but with the fragments available for comparison it is impossible to make indentifications of value; the same is true of the associated pygidium, of which only the central portion is known; this indicates, however, a comparatively broad margin. *Coosia daunus* (Walcott)¹, although having a similar frontal limb and form of glabella, undoubtedly belongs to a different genus or subgenus; this is indicated by its very strongly pitted surface.

A second species from Alabama, *C. robusta* (pl. 16, figs 2, 2a), is illustrated for comparison as it has a well preserved cranium and the pygidium is proportionately more elongate than that of *C. superba*.

Another form that is very close to this species is *Anomocare limbatum* Angelin. It differs materially, however, in having the very large eye-lobe characteristic of *Anomocare læve* (pl. 17, fig. 1), the type of the genus *Anomocare*. I think that in all probability with the securing of entire specimens of *A. limbatum* the species will be found to have characters intermediate between *Coosia* and *Anomocare*. For the present, however, I will refer it to the genus *Coosia*, subgenus undetermined.

¹ Referred in 1905 to the genus *Anomocarella*.

Formation and locality.—Middle Cambrian: (91) Conasauga (Coosa) shales, at Cedar Bluff, Cherokee County, Alabama; (16) limestones in Conasauga (Coosa) shales, Blountsville Valley, Blount County, Alabama; and (107) limestone in Bull Run, northwest of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville, Knox County, Tennessee.

Collected by A. M. Gibson and Cooper Curtice.

COOSIA ROBUSTA, new species

Plate 16, figs. 2, 2a

Of this species the cranidium and pygidium are known. The cranidium differs from that of *C. superba* (pl. 16, fig. 1) in having a proportionately more elongate glabella, more convex frontal border, and narrower postero-lateral limbs.

The pygidium differs in being more elongate, in having a proportionately longer axial lobe, and less flattened pleural lobes.

Formation and locality.—Middle Cambrian: (107) limestone in Bull Run, northwest of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville, Knox County, Tennessee.

Collected by Cooper Curtice.

BATHYURISCUS MANCHURIENSIS, new species

Plate 16, figs. 4

This species is founded on numerous specimens of the cranidium, free cheeks, thoracic segments, and pygidia that are compressed in a fine argillaceous shale. Unfortunately, there are no entire specimens of the dorsal shield.

As restored by combining the free cheeks and cranidium, the cephalon is semicircular in outline and moderately convex. It is bordered by a narrow, slightly rounded margin that is separated by a sharply defined narrow furrow from the glabella and the slope of the free cheeks. The posterior border is very narrow, elevated, and separated from the fixed cheek by a strongly defined furrow; the palpebral lobes are narrow and a little less than one-fourth the length of the cephalon. Genal angles extended into short, sharp, backward curving spines. The cranidium is broad at the base, narrowing toward the front; the antero-lateral limbs are very small and disappear where the palpebral lobe touches the dorsal furrow; the postero-lateral limbs and narrow fixed cheeks merge into each other so as to form transversely subtriangular areas, with the narrow palpebral lobes on their front outer margins.

Glabella large, subquadrangular in outline, and separated from the fixed cheeks by clearly defined dorsal furrows; its sides are nearly parallel or slightly diverging; front broadly rounded, almost transverse; surface marked by five pairs of furrows, the posterior of which extends obliquely across the posterior portion nearly to the center and separates a small triangular lobe on each side; the next two anterior pairs of furrows are short and extend inward at right angles to the side of the glabella; the next pair is nearly opposite the front end of the palpebral lobe; the anterior furrows are short and extend obliquely inward subparallel to the front margin of the glabella. Occipital ring narrow at the sides, widening toward the center where it is marked by a small sharp node a little back of the transverse center. Free cheeks large and surmounted on the inner side by a narrow eye lobe. The facial sutures cut the posterior margin a little within the genal angle and extend obliquely inward and slightly forward to the base of the eye lobes; curving over and around the eye lobes, they extend forward and downward, cutting the front margin on a line with the posterior base of the eye lobe. Number of thoracic segments unknown. Single specimens of the segments show that the axial lobe was nearly as wide as the pleural lobes, that it was moderately convex, and that a small node occurs at the center of each segment near the posterior margin; also that on the outer side of each segment a rounded transverse node is outlined from the main body of the segment by a slightly oblique transverse furrow; pleural lobes nearly flat out to the geniculation where they curve gently downward; each pleura has a furrow that is broad at its inner end next to the axial lobe and gradually narrows to the geniculation, where it terminates within the somewhat broadly rounded outer extremity; in well-preserved specimens a rounded ridge starts near the inner end of the pleural furrow and extends outward one-fourth of the length of the furrow.

The associated pygidia are semicircular, with the anterior margin almost transverse in the compressed specimens. The axial lobe is large and quite distinctly marked; it is divided by three transverse furrows into three rings and a terminal section that ends just within the outer border; a small node occurs near the posterior margin at the center of each ring; five anchylosed segments are outlined on the pleural lobes by furrows that progressively curve more and more backward from the first to the posterior one which adjoins the terminal segment; the furrows all terminate within the narrow, slightly flattened border.

The casts of the outer surface indicate that it was smooth or minutely granulose.

Observations.—This species appears to be quite distinct from any that has been described. The quadrangular glabella with nearly parallel sides distinguishes it from *Bathyriscus howelli* Walcott and *B. productus* (Hall and Whitfield).

Formation and locality.—Middle Cambrian: (36g) (36h) and (35o) Fu-chóu series; shales about 130 feet (40 m.) above the white quartzite on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liau-tung, Manchuria, China.

Collected by J. P. Iddings and Li San.

ASAPHISCUS IDDINGSI, new species

Plate 16, fig. 3

Dorsal shield longitudinally oval in outline, moderately convex. Cephalon semicircular in outline; a little more than one-third of the entire length of the dorsal shield; bordered by a nearly flat or slightly rounded margin that passes at the genal angle into a moderately strong genal spine; within the genal spine a rounded posterior border is separated from the fixed cheek by a rounded, clearly defined furrow; the interborder furrow is shallow and rounded. Cranidium moderately convex and roughly subquadrate in outline; the frontal limb is slightly convex and, with the anterior portion of the glabella and the front margin, forms a gentle slope that is broken only by the slight dorsal furrow in front of the glabella and the shallow intermarginal furrow; the frontal limb merges on the sides into the fixed cheeks which are a little less than one-half the width of the glabella; posteriorly the fixed cheeks merge into relatively small postero-lateral limbs; palpebral lobe narrow and extended in front as a low ridge that crosses the fixed cheek to the dorsal furrow near the antero-lateral angle of the glabella; that portion of the palpebral lobe above the eye is about one-fourth the length of the cephalon.

Glabella large, slightly narrower in front than at the occipital furrow; sides nearly straight and slightly converging, frontal margin broadly rounded; surface marked by very faint impressions of three pairs of glabellar furrows, which can only be seen where the surface is very perfectly preserved. Occipital ring about as wide as the frontal margin and separated from the glabella by a shallow furrow that terminates on the side slightly in advance of the posterior intermarginal furrow. Free cheeks about as wide opposite the eye as the fixed cheeks; eye lobe about one-fourth the length of the cephalon. Postero-lateral angle continued backward into a moderately strong

spine. The facial sutures cut the posterior margin just within the genal angle and extend obliquely inward with a slightly sigmoid curvature to the base of the eye lobes; curving over and around the eye lobes, they pass forward and a little outward, cutting the frontal margin obliquely.

Thorax with nine segments; axial lobe moderately convex, slightly narrower than the pleural lobes in compressed specimens; on the outer side of each segment a low rounded node or ridge is separated from the main body of the segment by a slightly oblique furrow transverse to the segment; pleural lobes slightly convex, nearly flat out to the geniculation where they curve slightly downward and backward; each pleura has a well-defined furrow starting near the inner anterior margin and extending backward to the center of the pleura at the geniculation, where it curves slightly backward and terminates on the broadly rounded, slightly falcate end of the pleura.

Pygidium roughly semicircular in outline, one-fourth the length of the dorsal shield; anterior margin nearly transverse at the axial lobe and curving slightly backward to conform to the curvature of the last thoracic segment; axial lobe moderately convex and tapering gradually toward its posterior section which is just within the nearly flat marginal border; it is divided by four transverse furrows into four rings and a terminal section; three anchylosed pleural segments are outlined on the pleural lobes by furrows that curve backward and terminate on the inner margin of the doublure; this line is continued forward on the pleural lobes of the thorax, terminating on each side opposite the posterior end of the facial suture.

Surface of specimens preserved in the limestone nearly smooth or marked by very minute shallow pits.

Dimensions.—A dorsal shield 30 mm. in length has the following dimensions:

<i>Cephalon:</i>	mm.
Length	11.0
Length of eye lobe.....	3.5
Width at posterior margin.....	20.0
Width of glabella at posterior margin.....	6.0
<i>Thorax:</i>	
Length	12.0
Width at fourth segment.....	19.0
Width of axial lobe at first segment.....	5.5
Width of axial lobe at ninth segment.....	4.0
<i>Pygidium:</i>	
Length	7.0
Width at union with thorax.....	12.0

Observations.—Fragments of this species are quite abundant in the limestones and interbedded shales. A few entire specimens are found in a fine argillaceous shale a short distance above the white quartzite at the base of the section, and it is from the best specimens of these that the above description was drawn, together with specimens of the cranidium in the limestone.

In general outline and appearance *Asaphiscus iddingsi* approaches the type of the genus, *A. wheeleri* Meek.¹ *Asaphiscus iddingsi* has a genal spine, a longer eye lobe, a proportionately shorter cephalon, and nine, instead of eight, segments in the thorax.

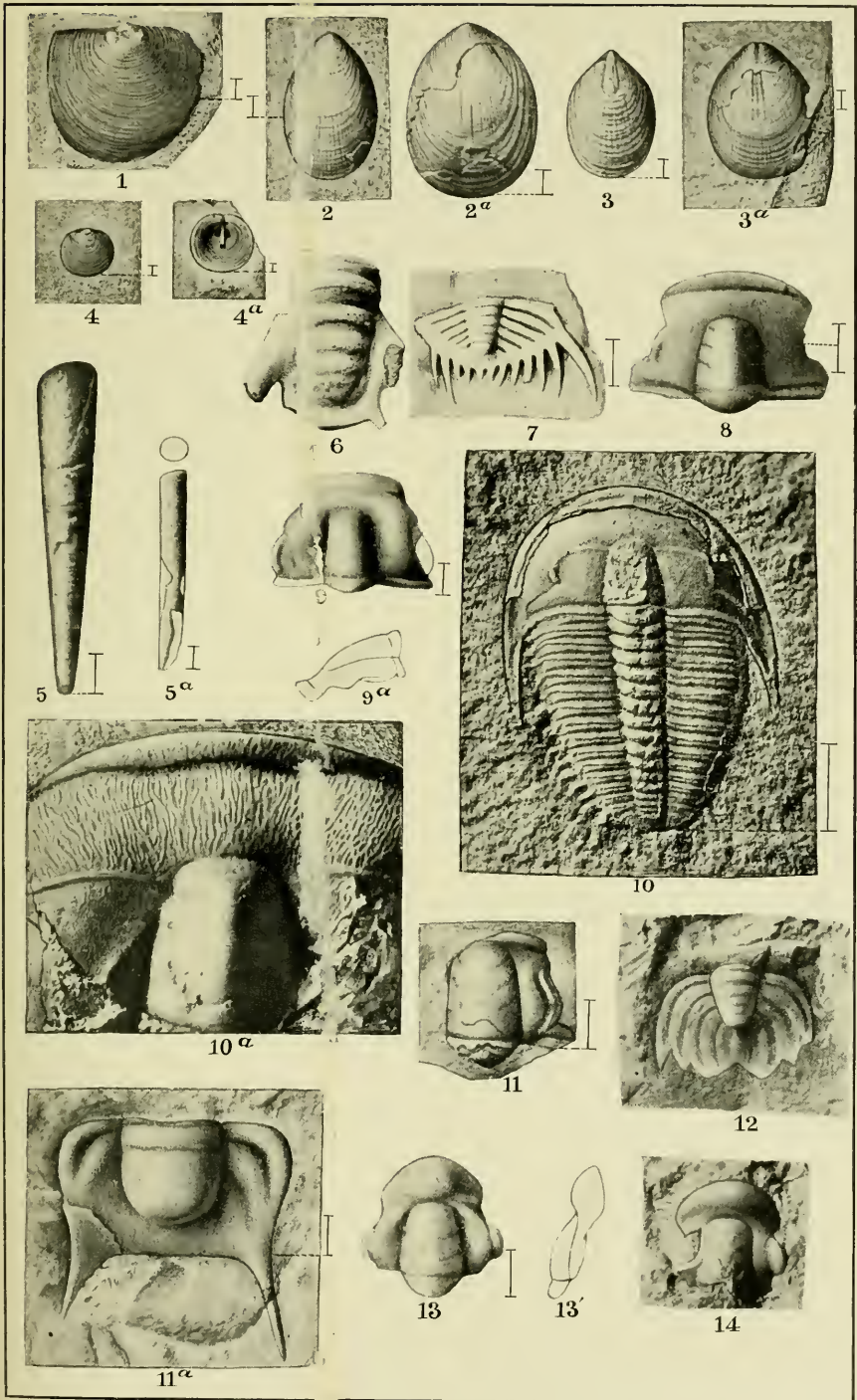
Formation and locality.—Middle Cambrian: (35r) (36e) Fu-chóu series; shales interbedded with limestones near the base of the series just above the white quartzite, collected in a low bluff on the shore of Tschang-hsing-tau island, east of Niang-niang-kung, Liautung, Manchuria, China.

Collected by J. P. Iddings and Li San.

¹Walcott, 1886, Bull. U. S. Geol. Survey, No. 30, pl. 31, fig. 3.

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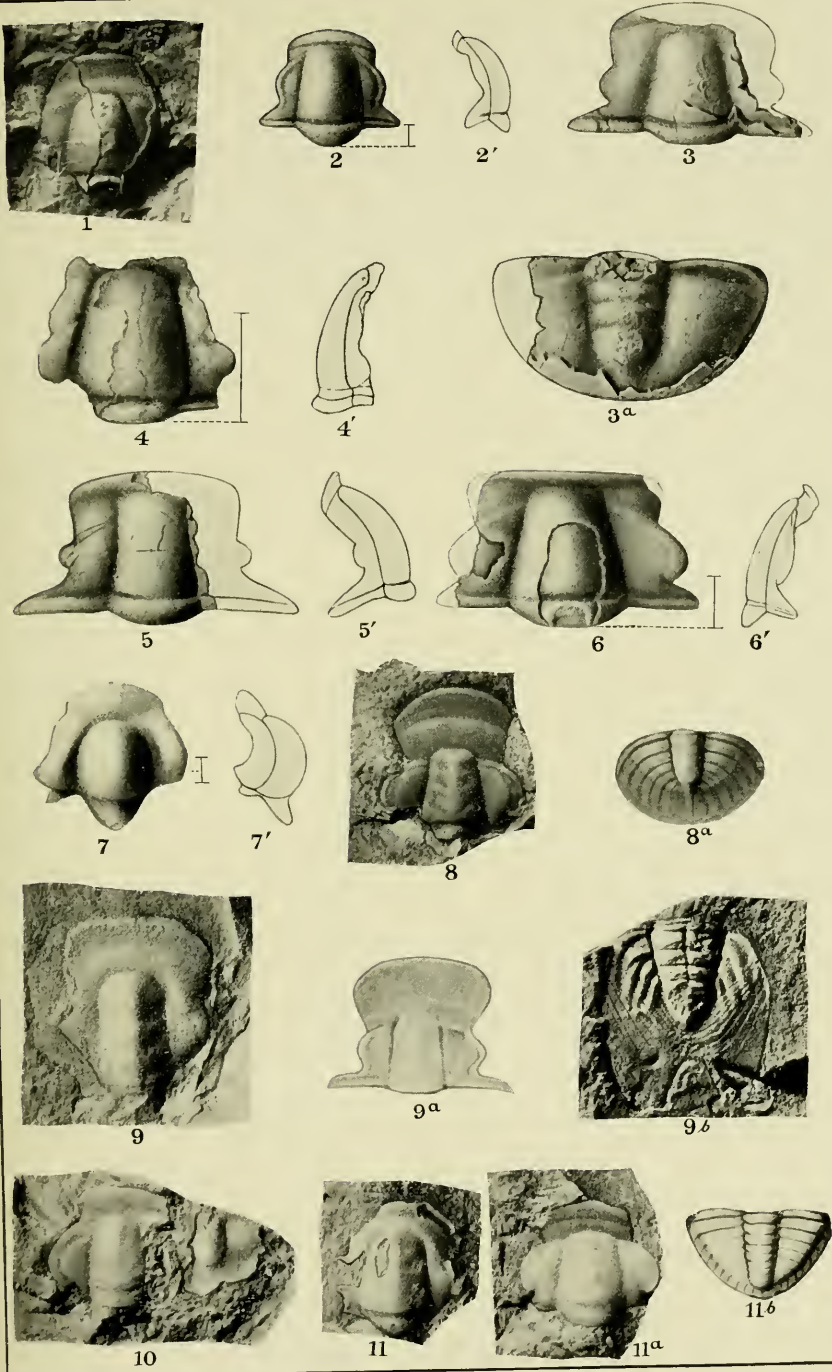


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¹By error a figure of the cranium of *Inouyia melie* = *Agraulos ? melie* Walcott 1906 was put on the plate instead of the cranium of *Inouyia capax*.

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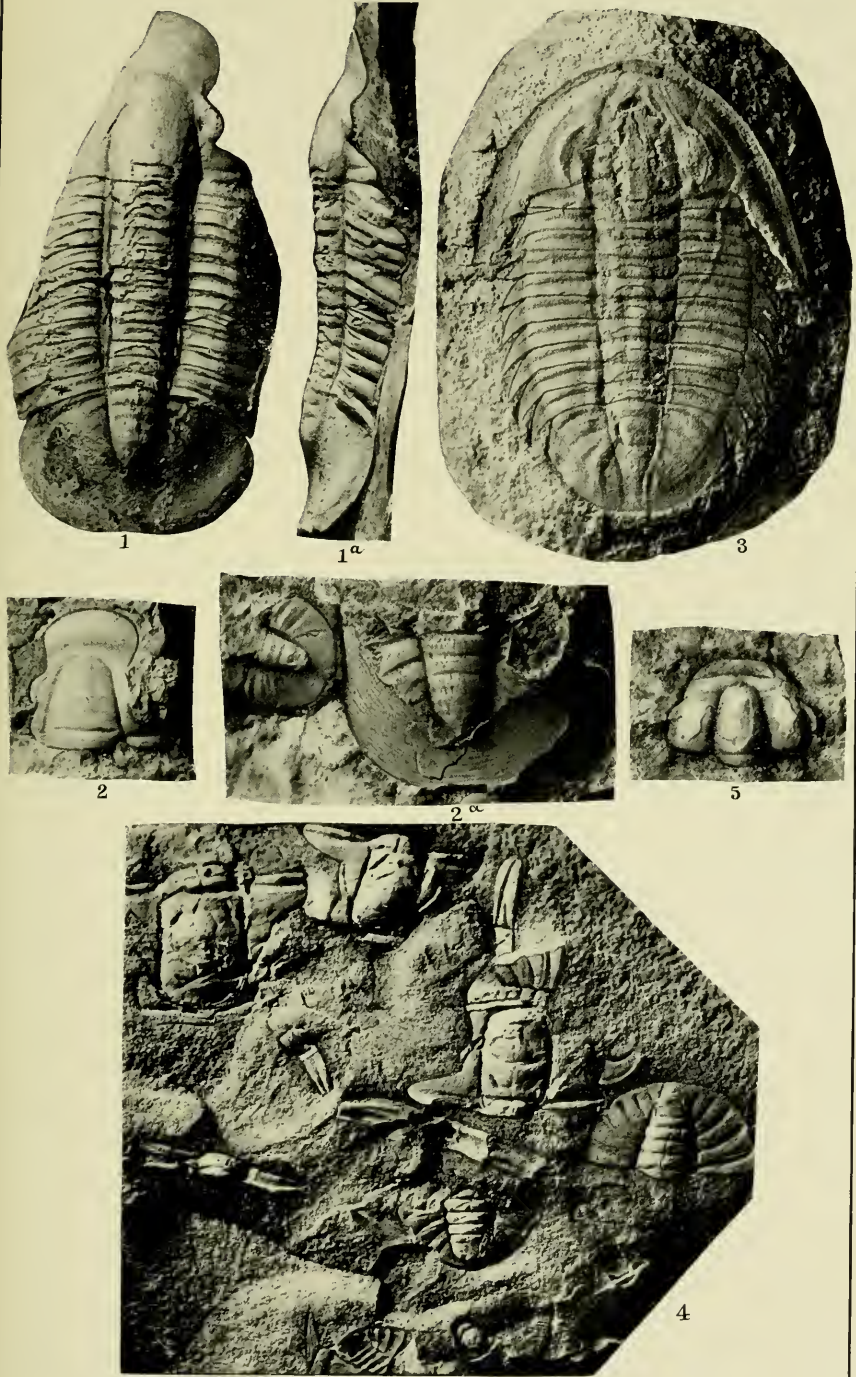
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CAMBRIAN FAUNAS OF CHINA

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FIGS. 4 and 4a. Dorsal and side views of cranidium. $\times 8$. U. S. National Museum, Catalogue No. 57599.	
<i>Levisia nasuta</i> Walcott (text figures 7 and 7a, page 87).....	87
FIG. 5. Dorsal view of cranidium ($\times 10$), the type specimen of the species and genus. U. S. National Museum, Catalogue No. 57600. (See text figures for side and front views.)	

