THE CAMBRO-ORDOVICIAN FORMATIONS AND FAUNAS OF SOUTH KOREA PART IX

PALAEONTOLOGY VIII
The Machari Fauna

By

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Teiichi KOBAYASHI

With Plates I-VIII

I. Introductory Notes

In 1935 when I had described 23 species in 16 genera of brachiopods and trilobites from the *Olenoides* zone of Neietsu, little was known of its stratigraphic position. This fauna was provisionally correlated to the Stephen fauna of western North America, because it contains *Olenoides*, *Kootenia* and *Tonkinella*. The areal survey of the Neietsu anticlinorium was later carried out in detail by YOSIMURA and HUKASAWA. When I have made the preliminary field work with YOSIMURA, I was fortunate enough to find *Olenus* at the Yŏngwŏl i. e., Neietsu coalfield.

Subsequently YOSIMURA (1940) divided the Cambro-Ordovician Chosen group of the anticlinorium into five formations and the classification was confirmed by HUKASAWA (1942). The Machari formation is one of them which is located between the Gakoku and Samposan formations. These two formations are, however, not very fossiliferous and their fossils are already described respectively in the parts VII and VIII in this series of publication.

The Machari formation is chiefly composed of bluish gray limestone, black argillaceous limestone, marl and black shale in alternation and rich in fossils at several horizons. The structure of the area is, however, highly complicated by thrusting and folding in addition to partial fluting of frequent alternation of thin-bedded rocks. Therefore it is very difficult to establish the zonation. However, the field observations combined with indoor work enabled me to distinguish two faunas in the so-called *Olenoides* zone of Neietsu.

The *Tonkinella* fauna containing *Peronopsis rakuroensis, Tonkinella kobayashii, Olenoides asiaticus, Mesocrepicephalus subquadratus* and *Anomocarella coreanica* occurs in the lower part of the formation. The *Eochuangia* fauna comprising *Phoidagnostus, Pseudagnostus, Komaspis, Eochuangia, Proceratopyge* and others is evidently younger in age and most widely spread. While the *Tonkinella* fauna is related to the Stephen, the *Eochuangia* fauna bears some affinity

* Received July 26, 1961.

with the Baltic fauna. These two faunas are containded in dark gray and bluish gray limestones, but the next three faunas are found in black shales.

The *Komaspis-Iwayaspis* zone yields some species of *Pseudagnostus*, *Eochuangia* and *Proceratopyge* which are common with the *Eochuangia* zone, but *Iwayaspis* is characteristic of this zone.

The *Olenus-Glyptagnostus* zone is Upper Cambrian and may be younger than the precedings.

Finally, the *Hancrania* shale of Pundŏk-ch'i may be close to the *Olenus* zone, although their stratigraphic relation is not well known.

The localities of fossils are cited below according to these zones. The Machari fauna described in this volume was collected by Messrs YOSIMURA and IWAYA, jointly with myself in part. My cordial thanks are due to them.

On this occasion I have described several fossils procured from North Korea and South Manchuria. Some of them were collected by Mr. K. SAITO from the Rinson shale in the Chunghua (Chuwa) area, south of P'yŏgnyang. The South Manchurian ones belong partly to my own collection and partly to the old institute collection made by Dr. Y. OZAWA and others. Here I record my thanks to these collectors.

It was a project in my studies on trilobites to restore Asiatic trilobites as much as possible. In taking up this project in 1940, the restored illustrations of *Drepanura premesnili* and some other Kushanian trilobites were drawn by Mr. Shiro SUZUKI and first published in my paper, *Studies on Cambrian Trilobite Genera and Families*. Since then more than three-quarters of Asiatic trilobite genera have been drawn by him with admirable skill, until his lamental death early in September, 1960. Here I wish to express my warmest thanks to him for his continuous assistance through some 20 years.

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1. List of Localities of the *Tonkinella* zone.
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   105. Ditto.
   109. Ditto.
   201. 500 m. SSW of Suang-dong (水央洞), Yŏngwŏl-myŏn (寧越面).
   219. 300 m. NE of Sŏltol (立石), Yŏngwŏl-myŏn, path to the royol tomb.
   293. 600 m. NE of Hasong-ch'i (下松峙), Puk-myŏn.
   296. SSE of Hasong-ch'i, Puk-myŏn.
   304. 1.4 km. E of Konggi-ri (恭基里), Puk-myŏn, E of 302 point.
   306. 1.9 km. E of Konggi-ri, Puk-myŏn.
   311. 150 m. S of Chik-kok (直谷), Puk-myŏn.
   Ita-10. 450 m. N of Nol-tari (板橋),Puk-myŏn.
   Nei-2. North of Yŏngwŏl.

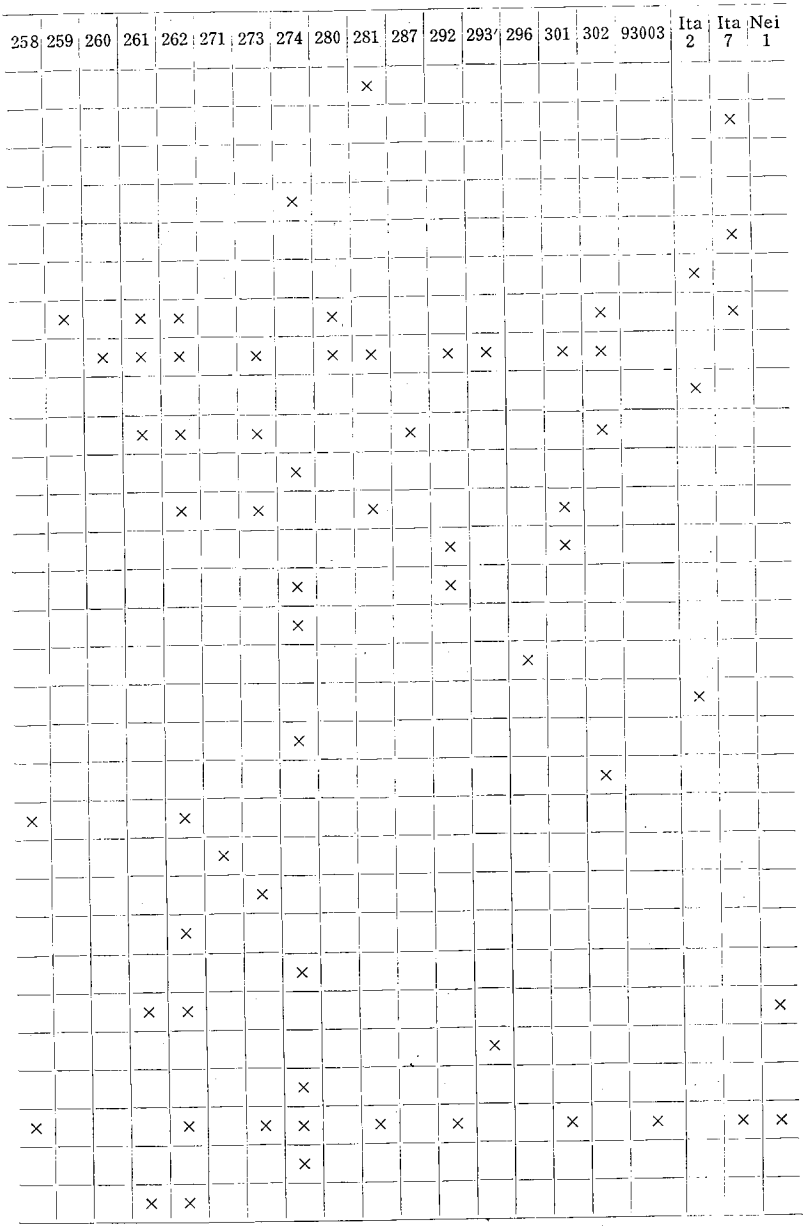
Table 1. Fossils from the *Tonkinella* Zone.

Fossil / Locality	104	105	109	201	219	293	296	304	306	311	Ita 10	Nei 2
Micromita coamisculptilis			×									
Peronopsis rakuroensis	×	×	×	×			×	×	×			
Olenoides asiaticus			×					×				
Tonkinella kobayashii		×	×			×		×	×		×	
Ptychoparia bipuncta			×									×
Elrathia spinifera									×	×		
Paragraulos parvicaulis												×
Yongwolia ovata											×	
Yongwolia kagasi											×	
Mesocrepicephalus subquadratus			×					×				
Mesocrepicephalus airaghii			×								×	
Anomocarella coreanica			×	×	×	×		×	×		×	
Anomocarella coreanica longa			×									
Anomocarella (*Entorachis*) *brevifrons*			×									
Anomocarella (*Entorachis*) sp.		×										
Lioparella longifolia		×										
Eymekops perlongatus			×									
Hypostomata, gen. and sp. indt.			×									

Table 2. Fossils from

Fossil \ Locality	111	200	204	225	226	227	228	229	245	255	257
Lingulella manchuriensis							×	×		×	
Paterina coreanica											
Acrotreta yongwolensis		×									
Propilina antiqua											
"*Kobayashiella*" *masariensis*											
Hyolithes cybele											
Phoidagnostus obsoletus		×			×			×	×	×	
Pseudagnostus primus		×	×						×	×	
Pseudagnostus marginisulcatus											
Eochuangia hana	×		×	×		×					
Lisania conica											
Komaspis (*Parairvingella*) *convexa*				×							
Elrathia taira											
Megagraulos medius											
Megagraulos breviscaps											
Metagraulos sp.											
Metagraulos (?) sp.											
Solenoparia subtoxea											
Mesocrepicephalus airaghii											
Anomocarella (*Entorachis*) *brevifrons*											
Anomocarella (*Entorachis*) *longifrons*							×				
Coosia (?) sp.											
Haniwoides longissimus											
Haniwoides tenuis											
Haniwoides (?) *puteolatus*				×	×						
Briscoia (?) sp.											
Proceratopyge (*Proceratopyge*) sp. indt.											
Proceratopyge (*Kogenium*) *rotundum*											×
Free cheek and pygidium, gen. and sp. indt.											
Pygidia, gen. and sp. indt.											

the *Eochuangia* Zone.



2. List of Localities of the *Eochuangia* zone.

111. 1.4 km. NE of Nŭng-dong (陵洞), Yŏngwŏl-myŏn (寧越面).
200. 500 m. SSW of Suang-dong (水央洞), Yŏngwŏl, E of a ridge.
204. 1.25 km. NE of Moha-ri (茅下里), Puk-myŏn (北面), on border with Yŏngwŏl-myŏn.
225. 400 m. E of Moha-ri, Puk-myŏn.
226. Ditto.
227. 300 m. ESE of Moha-ri, Puk-myŏn.
228. 650 m. NE of Sŏltol (立石), Yŏngwŏl-myŏn, NW of 292 m. point.
229. Ditto.
245. 550 m. N of Suang-dong, Yŏngwŏl-myŏn, at pass of Pundŏk-ch'i (分德峙).
255. 1.2 km. NE of Mach'a-ri (磨碴里), Puk-myŏn, W of Nŏl-tari (板橋).
257. 1.1 km. NE of Mach'a-ri, Puk-myŏn, SW of Nŏl-tari.
258. Ditto.
259. Ditto.
260. Ditto.
261. Ditto.
262. 900 m. NE of Mach'a-ri, Puk-myŏn, SW of Nŏl-tari.
271. 500 m. S of Kok-kol (谷洞), Puk-myŏn, NNW of Pundŏk-ch'i, NE of 213 m. point.
273. 750 m. S of Kok-kol, Puk-myŏn, NW of Pundŏk-ch'i, S slope of cableway.
274. 1.25 km. W of Kok-kol, Puk-myŏn, NNE of Chŭng-san (甑山).
280. 500 m. NNW of Kok-kol, Puk-myŏn, W of Pundŏk-ch'i.
281. Ditto.
287. 400 m. S of Hasong-ch'i (下松峙), Puk-myŏn.
292. 850 m. S of Hasong-ch'i, Puk-myŏn, SSE of 287 m. point.
293'. 600 m. NE of Hasong-ch'i, Puk-myŏn.
296. 300 m. SSE of Hasong-ch'i, Puk-myŏn.
301. 1.15 km. SE of Konggi-ri (恭基里), Puk-myŏn.
302. E. of Konggi-ri at junction with a big south valley, Puk-myŏn.
93003. Mudong-gol (舞童谷), Yongong-ni, Puk-myon, (Boulder).
Ito-2. Song-ch'i (松峙), 1.45 km. NE of Mach'a-ri, N of Nŏl-tari, Puk-myŏn.
Ita-7. Ditto.
Nei-1. North of Yŏngwŏl.

3. List of Localities in Black Shales.

196. 400 m. S or SW of Suang-dong (水央洞), Yŏngwŏl-myŏn.
197. Ditto.
199. Ditto.
241. Pundŏk-ch'i (分德峙), 550 m. NW of Suang-dong, Yŏngwŏl-myŏn; *Glyptagnostus* zone.
242. Ditto. *Hancrania* zone.
256. W of Nol-tari (板橋), 1.2 km. NW of Mach'a-ri (磨碴里), Puk-myŏn.
313. Middle part of South Slope of Mt. Sambang-san (三方山), 1.1 km. E of Set'o (新垈), Puk-myŏn. *Iwayaspis* zone.
Ita-1. 450 m. N of Nol-tari, 1.45 km. NE of Mach'a-ri, Puk-myŏn, *Glyptagnostus* zone.
Ita-11. Songch'i, N of Nol-tari, Puk-myŏn.
Matsutoge. Adjacently N of Ita-1. *Glyptagnostus* zone.

Table 3. Fossils from the Black Shale Facies.

Fossil \ Locality	196	197	199	241	242	256	313	Ita 1	Ita 11	Song Ch'i
Glyptagnostus reticulatus				×				×		×
Phalacromina minor					×					
Homagnostus hisakoshii	×	×					×		×	
Pseudagnostus primus	×						×			
Eochuangia hana conica	×		×							
Komaspis (Parairvingella) megalops	×		×				×			
Olenus asiaticus				×				×		
Hancrania brevilimbata					×					
Ctenopyge (?) sp.	×									
"Hedinaspis" granulatum					×					
Rhodonaspis (?) *similis*					×					
Acrocephalina trisulcata								×		
"Westergaardella" coreanica					×					
Anomocarella (Entorachis) gracilis						×				
Koptura bispinata		×	×				×			
Koptura cfr. *bispinata*			×							
Eymekops mesops							×			
Proceratopyge (Kogenium) rotundum			×							
Proceratopyge (Lopnorites) rectispicatus							×			
Proceratopyge (Lopnorites) robustus							×		×	
Iwayaspis asaphoides	×		×				×			
Meraspid, gen. and sp. indt.			×							
Meraspid (?) gen. and sp. indt.									×	

III. Description of Fossils

In this chapter the descriptions are given of about 60 species of fossils beside some 20 indeterminable forms, including 35 new species and one new subspecies in addition to 6 new genera, 2 new subfamilies and 2 new families listed below.

Protoscaevogyridae
Protoeccyliopteridae
Iwayaspidinae
Lioparellinae

Hancrania
Iwayaspis
Lakella
Phalacromina
Westergaardella
Yongwolia
Acrotreta yongwolensis
Amecephalus saitoi
Anomocarella coreanica
Anomocarella coreanica longa
Anomocarella (*Entorachis*) *gracilis*
Elrathia spinifera
Elrathiella taira
Eymekops mesops
Eymekops perlongatus
Hancrania brevilimbata
Haniwoides longissimus
Haniwoides ? *puteolatus*
Haniwoides tenuis
"*Hedinaspis*" *granulatum*
Homagnostus hisakoshii
Iwayaspis asaphoides
"*Kobayashiella*" *masariensis*
Komaspis (*Parairvingella*) *megalops*
Koptura bispinata
Lioparella longifolia
Lisania conica
Megagraulos breviscapus
Megagraulos medius
Micromitra coamisculptilis
Paragraulos parvicaulis
Paterina coreanica
Phalacromina minor
Proceratopyge (*Lopnorites*?) *robustus*
Propilina antiqua
Pseudagnostus marginisulcatus
Ptychoparia bipuncta
Rhodonaspis (?) *similis*
Solenoparia subtoxea
"*Westergaardella*" *coreanica*
Yongwolia kagasi
Yongwolia ovata

As I have already discussed many families of the Redlichiida, and Corynexochida and some of the Ptychopariida, special attention is paid here on the Ptychopariina and lengthy discussions are given on the Ptychopariidae, Olen-

idae, Emmrichellidae, Conokephalinidae, Asaphiscidae and Anomocaridae. In addition, miscellaneous notes are presented as to the Eodiscina, Agnostina, Komaspididae, Solenopleuridae, Crepicephalidae and so forth.

Finally, the classification of the Cambrian polymeric trilobites is discussed with special reference to Asiatic groups.

Phylum Brachiopoda

Class Inarticulata

Order Atremata BEECHER, 1891

Family Obolidae KING, 1846

Genus *Lingulella* SALTER, 1886

Lingulella manchuriensis WALCOTT, 1911

Plate III, Figure 9. PB3984

1911. *Lingulella manchuriensis* WALCOTT, *Smithson. Misc. Coll. Vol. 57, No. 4*, p. 74, pl. 14, figs. 2, 2a.
1911. *Lingulella marcia* WALCOTT, *Ibid. Vol. 57, No. 4*, p. 74, pl. 14, figs. 3, 3a.
1913. *Lingulella manchuriensis* WALCOTT, *Cambrian Faunas of China*, p. 69, pl. 3, figs. 1, 1a-e.
1913. *Lingulella marcia* WALCOTT, *Ibid.* p. 69, pl. 2, figs. 6, 6a-f.
1916. *Lingulella* cf. *manchuriensis* MANSUY, *Mém. Serv. géol, l'Indochine, Vol. 5, Fasc, 4.* p. 11, pl. 1, figs. 7a-b.
1916. *Lingulella* cf. *marcia* MANSUY, *Ibid. Vol. 5, Fasc. 4*, p. 11, pl. 1, figs. 8a-b.
1935. *Lingulella marcia* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 64, pl. 14, fig. 1.
1935. *Lingulella manchuriensis* KOBAYASHI, *Ibid. Sec. 2, Vol. 4, Pt. 2*, p. 64, pl. 14, fig. 3.
1937. *Lingulella manchuriensis* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 124, pl. 24, figs. 7, 9-12, 14, 15; pl. 25, fig. 4.
1937. *Lingulella marcia* RESSER and ENDO, *Ibid. Bull. 1*, p. 124, pl. 24, figs. 1-6, 8.
1944. *Lingulella manchuriensis* ENDO, *Bull. Central Nat, Mus. Manch. No. 7*, p. 54.

My opinion of uniting *marcia* with *manchuriensis* was endorsed by ENDO (1944).

Occurrence:—*Eochuangia* zone at locs. 228, 229, 255 and 281; *Solenoparia* zone of Doten, South Korea; Mapanian of Liaotung; *Anomocare subquadratum* zone and *Conokepalina* zone of Tienfong, Yunnan-Tonkin border.

Order Neotremata BEECHER, 1891

Family Paterinidae SCHUCHERT, 1893

Genus *Paterina* BEECHER, 1891

Paterina coreanica KOBAYASHI, new species

Plate III, Figure 8. PB3985

A ventral valve fairly convex, a little broader than long, widest at about a fourth from umbo which is tiny and only a little protruded; area obscure;

surface marked with innumerable fine regularly concentric ridges, a few of which are prominent; no radial sculpture.

Paterina lucina WALCOTT and *P. orientalis* WALCOTT are known respectively from the Middle Cambrian of Liaotung and Shantung, and *P. talingensis* WANG from the Lower Cambrian of Liaoning. This is the fourth species in the Far East. It is different from the precedings in the greater length and convexity of the valve, small but prominent umbo, regular concentric ornaments and lack of radials.

Occurrence:—*Eochuangia* zone; Ita 7.

Genus *Micromitra* MEEK, 1873

Micromitra coamisculptilis KOBAYASHI, new species

PB3986 ✓
(PA 3986)

Plate I, Figure 21.

1913. Aff. *Micromitra sculptilis* WALCOTT, non MEEK, *Cambr. Fauna of China*, p. 61, pl. 1, figs. 6, 6a.

The ventral valve in hand shows the net-work typical of *Micromitra* on its test. In the mesial part there are fairly strong radial ridges which start from umbo; a few concentric growth wrinkles also very pronounced. Though the valve is imperfect, it is evidently similar to WALCOTT's *Micromitra sculptilis* from Manchuria in outline and convexity. Compared to his ventral valve in fig. 6 the umbo is more stout and radial ridges are more numerous in this valve.

The *sculptilis* in the Rockies (WALCOTT, 1912) appears to have regular radials and concentrics and the umbo of the ventral valve is probably less protruded.

Occurrence:—*Tonkinella* zone; Loc. 109. This is the first report of occurrence of *Micromitra* in South Korea.

Family Acrotretidae SCHUCHERT, 1896

Genus *Acrotreta* KUTORGA, 1848

Acrotreta yongwolensis KOBAYASHI, new species

PB3987-3-6
PB3988-3-7 ✓

Plate III, Figures 6-7.

Description:—Ventral valve low, conical with apex near the posterior margin; base subcircular, its diameter being almost thrice the height of the cone; false area subvertical, ill-defined. Internally, apical callosity of moderate size; foraminal tube clearly impressed; a pair of visceral areas found in front of this cast; vascular sinus extending diagonally from this area for a short distance. Dorsal valve circular, slightly inflated; median septum across posterior half; concentric ridges fairly stout.

Comparison:—The cone of this ventral valve is much lower, if compared with those of WALCOTT's *venia, lisani, pacifica, shantungensis* and some other

some other Asiatic species. The rugose appearance of concentric sculpture is another characteristic of this species.

Occurrence:—*Eochuangia* zone; Loc. 200.

Phyllum Mollusca

Class Monoplacophora WENZ in KNIGHT, 1952

Order Tryblidioidae LEMCHE, 1957

Family Tryblidiidae PILSBRY in ZITTEL-EASTMAN, 1899

Genus *Propilina* KOBAYASHI, 1937

Propilina antiqua KOBAYASHI, new species

Plate II, Figures 20a-b, 21a-b.

PM3989-2-20
PM3990-2-21

Description:—Shell patelliform with apex fairly high, protruded anteriorly (?) and incurved; aperture somewhat oval, but very broad and only slightly narrower in anterior (?); surface ornamented by numerous, fine, concentric, more or less wavy growth striae some of which are thicker than many others; test thick, internally undulated and faintly marked by radial lines; muscular scars unkown.

Observation and comparison:—Five specimens are at hand two of which are, however, very fragmentary. A smallest specimen which is selected for the holotype has the aperture 6 mm. by 7 mm. The apical portion is protruded no more than a quarter of the length and so abruptly incurved that the apex is drooping down. The shell is largely exfoliated. The internal radial lines are impressed there as seen by cross light on the posterior (?) side.

The largest specimen whose apical portion is broken off is 12 mm. high; its aperture 22 mm. wide and 26 mm. long. The test is better preserved in this than the preceding and shows numerous concentric striae.

There are two Wanwanian species of *Propilina* in Eastern Asia (KOBAYASHI, 1933). One is *P. ampla* which, compared to this, has a narrower shell and quite convex. Its maximum height lies near the center of the aperture which is elliptical and narrow. *P. bridgei* is the other which is quite distinct from this species in the low shell.

Occurrence:—*Eochuangia* zone at loc. 274.

Class Gastropoda CUVIER, 1797

Order Archaeogastropoda THIELE, 1925

Superfamily Macluritacea FISCHER, 1885

Family Onychochilidae KOKEN, 1925

Genus *Kobayashiella* ENDO, 1937

1937. *Kobayashiella* ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 314.

1941. *Kobayashiella* KNIGHT, *Geol. Soc. Am. Sp. Pap. No. 32*, p. 165.
1960. *Kobayashiella* KNIGHT, BATTEN and YOCHELSON, *Treatise on Invert. Pal. Pt. I-1*. p. 1187.

Type-species:—*Straparollina circe* WALCOTT, 1905.

Remarks:—As WALCOTT (1913) referred his *circe* to *Matherella*, it is closely allied to *Matherella walcotti* KOBAYASHI, 1933, which is the type species of *Matherellina*. They are both trochiformed gastropods having similar low undulations on the test. The spire is, however, much lower in *Kobayashiella* than in *Matherellina*. *Kobayashiella* was once suggested to be synonymous with *Scaevogyra* (SHIMER and SHROCK, 1944), but the latter having *Natica*-like smooth shell is quite distinct from the former.

ENDO said in his diagnosis of *Kobayashiella* that "Spire composed of volutions that are rather *depressed*". This statement was undoubtedly derived from WALCOTT's description of "spire depressed". Nevertheless, the elevated spire of monotypic *circe* is clearly shown in KNIGHT's illustration, 1941, and also in WALCOTT's fig. 5, (1913). While WALCOTT's *circe* was procured together with *Dictyites*, *Pagodia* and other late Upper Cambrian trilobites in Shantung, ENDO's *circe* is represented by three specimens from the Kushanian of Liaotung which appear to have depressed spires. One of them shows elevated narrow ridges on the last whorl. Therefore ENDO's *circe* is specifically distinct from WALCOTT's.

"*Kobayashiella*" *masariensis* KOBAYASHI, new species

PM3991 ✓ Plate III, Figures 4a-b.

Description:—Spire composed of about two volutions very rapidly expanding and coiling almost in a plane; inner volution a little sunken below the upper face of the outer volution. Whorl section subtrigonally ovate; upper wall slightly inflatted but becomes well rounded near periphery; lateral and lower walls broadly rounded. Surface marked with narrow grooves separated by wide intervals which are transversal on upper surface but gently arcuate with forward convexity and swinging back on lateral side; some finer sculptures seen on the intervals; umbilical side not well known.

Comparison:—ENDO's *circe*, 1937, may be the closest ally to this species. His species consists apparently of three volutions and has distinct ridges which are fairly dense. *Protoscaevogyra reversa* agrees with the precedings in the sinistral and nearly planispiral coiling, but differs from them in the more gradual coiling, horizontal flat upper plane, scarcely sunken apex, subelliptical whorl section and smooth test. These three species have no plane of symmetry. Therefore there is no possibility that either one of them is confused with *Strepsodiscus* KNIGHT, 1948, which is a bellerophont genus.

Occurrence:—*Eochuangia* zone; Ita 7.

Family Protoscaevogyridae KOBAYASHI, new family

Genus *Protoscaevogyra* KOBAYASHI, 1939

1939. *Protoscaevogyra* KOBAYASHI, *Jubilee Publ. Comm. Prof. Yabe's 60th Birthday. Vol. 1*, p. 286.

Type-species:—*Pelagiella* (?) *reversa* KOBAYASHI, 1935. (Fig. 1a-b).

Remarks:—The most resembling to this genus may be *Maclurites*, both having the flat base, subangulate periphery of the whorl and deep umbilicus, but its discoidal shell readily distinguishes it from *Maclurites*. The whorl and spire are more rapidly expanding in it than in *Euomphalopsis* and other discoidal macluritoids. The two essential distinctions of this genus from these allies are the much broader section of the whorl and its very rapid growth.

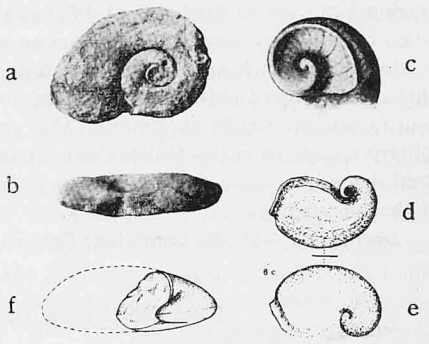


Fig. 1.

a-b. *Proscaevogyra reversa* (KOBAYASHI) ×1.5 from KOBAYASHI, 1935, figs. 5-6, pl. XI.
c. *Proeccyliopterus chronus* (WALCOTT) ×10 after WALCOTT, 1913, fig. 9, pl. 5.
d-e. *Pelagiella atlantoides* (MATTHEW) ×2 after MATTHEW, 1892, figs. 6a & 6c.
f. *Pelagiella atlantoides* (MATTHEW) ×2 from KNIGHT, BATTEN and YOCHELSON in Treatise, I, 1, 1960, Fig. 216-2.

KNIGHT (1952) has synonymized this genus with *Pelagiella*, but *Pelagiella* (Fig. 1f) is quite different from this genus in the whorl section, especially in the stronger asymmetry and the well developed umbilicus of this genus. He noted further (1948) that "there is a possibility that *Strepsoidiscus* may prove to be congeneric with *Protoscaevogyra* KOBAYASHI", but the least possibility for their congenity is now self-evident from the above statement.

It is my opinion that *Protoscaevogyra* is probably an early off-shoot of the Macluritacea.

Distribution:—Kushanian of Korea.

Superfamily Euomphalacea DE KONINCK, 1881

Family Proeccyliopteridae KOBAYASHI, new family

Genus *Proeccyliopterus* KOBAYASHI, 1939

1939. *Proeccyliopterus* KOBAYASHI, *Jubilee Publ. Comm. Prof. Yabe's 60th Birthday, Vol. 1*, p. 286.

Type-species:—*Platyceras chronus* WALCOTT, (Fig. 1c).

The peripheral carination is the most distinctive characteristic of this genus which definitely distinguishes it from *Pelagiella* (Fig. 1d-e). Therefore it is most difficult for me to understand the congenity of *Proeccyliopterus* with *Pelagiella* which was repeatedly insisted by KNIGHT (1948, 1952).

WALCOTT states that "the striae of growth arch backward to the ridge, indicating a sharp but small dorsal sinuosity in the peristome". In this aspect and in the location on the whorl and accordingly in its biological bearing I can see no fundamental difference of this carination from the augulation on the whorl commonly seen among euomphaloids.

In my opinion it agrees best with the Euomphalidae, s. l. or the Euomphalacea in modern sense, but it is quite improbable for this genus to belong to any post-Cambrian family. The genus is so far represented by a solitary species from the Middle Cambrian of Shantung and there is no Upper Cambrian euomphaloid. Therefore this genus must be a small early off-short of the superfamily.

Distribution:—Middle Cambrian; Eastern Asia.

Class Eopteropoda TERMIERS, 1947

or Coniconchia LIASHENKO, 1957

Family Hyolithidae NICHOLSON

Genus *Hyolithes* EICHWALD, 1840

Hyolithes cybele WALCOTT, 1905

PM3992

Plate III, Figure 5.

1905. *Hyolithes cybele* WALCOTT, *Proc. U. S. Nat. Mus. Vol. 29*, p. 17.
1913. *Hyolithes cybele* WALCOTT, *Cambrian Fauna of China*, p. 92, pl. 5, figs. 16, 16a-c; pl. 6, figs. 7.
1937. ? *Hyolithes crebescens* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 151, pl. 28, figs. 15-17; pl. 29, figs. 5-6.

Hyolithids are uncommon in the Cambrian of South Korea. Insofar as one can see on the dorsal face, the hyolithid at hand agrees with *H. cybele* in the longicone having the apical angle of about 15 degrees, strongly arcuate growth striae and absence of longitudinal markings.

Occurrence:—*Eochuangia* zone at Loc. Ita 2. WALCOTT's *cybele* including *crebescens* is reported from the Mapanian and Taitzuan of Shantung and Liaotung.

Phylum Arthropoda SIEBOLD & STANNIUS, 1845

Class Trilobita WALCH, 1771

Subclass Miomera JAEKEL, 1909

Order Agnostida KOBAYASHI, 1935

Suborder Eodiscina KOBAYASHI, 1939

At present it is generally accepted that eodiscids and agnostids indicate two major groups of miomeric trilobites and no palaeontologist intends to exclude the Agnostina out of the Trilobita. The morphological coincidence of the Eodiscina with polymeric trilobites is now well ascertained not only with their dorsal shields but also with the hypostoma of *Pagetia* as reported by ÖPIK (1952). The geological range of the Eodiscina is still confined to the Lower and Middle Cambrian. For the geographical distribution it is certainly remarkable that the Pagetidae have flourished greatly in the early Cambrian of Northern Asia where they revealed wide morphic divergence.

In 1935 I have erected the proparian Pagetidae to distinguish the family from the hypoparian Eodiscidae. Subsequently, in 1943 and 1944 I have carried out an extensive revision of the eodiscids. As the result I classified them into 5 families including 6 subfamilies. On that occasion, however, I could not have access of LERMONTOVA's work (1940) in which she added *Cobboldia*, *Glabrella*, *Pagetiellus*, *Pagetina* and *Triangulaspis* to the Pagetidae. I have overlooked also RICHTERS' paper (1941) in which they synonymized the Pagetidae and Dawsoniidae with the Eodiscidae of which they accepted only one genus, *Eodiscus*, although they divided it into three subgenera, *Eodiscus*, *Serrodiscus* (nov.) and *Weymouthia*. Next year they commented that *Glabrella* and *Triangulaspis* are not eodiscids and that the validity of *Pagetina* is doubtful.

RASETTI (1945, 1948) on the other hand accepted the Pagetidae in which he erected *Pagetides* for the Lower Cambrian forms. WESTERGÅRD (1946) described an interesting eodiscid with a pair of tubercles on the cheeks for which he proposed *Aulacodiscus*. Subsequently it was replaced by *Opsidiscus* WESTERGÅRD, 1949, on account of the preoccupation of the same name by *Aulacodiscus* DOUVILLÉ, 1921. Then (1950) SHAW synonymized *Hebediscus* with *Dipharus* by the reason that they were founded respectively on the adult and larval form of an identical species. However, he accepted *Eodiscus* and *Weymouthia* as two distinct genera of the Eodiscidae and *Serroidiscus* and *Paradiscus* as two distinct subgenera of *Eodiscus*, but he synonymized Hebediscidae and Dipharidae with the Pagetidae.

In the revision of the North American eodiscids (1953) RASETTI pointed out the synonymy of *Paradiscus*, *Spinodiscus*, *Brevidiscus*, *Deltadiscus* and *Alemtejoia* respectively with *Serrodiscus*, *Eodiscus Calodiscus*, *Eodiscus*, and *Delgadoia*. He surpressed *Eopagetia* and *Mesopagetia*, while he proposed *Neocobboldia* for *Cobboldia* LERMONTOVA, 1940, non BRAUER, 1887, nec LEIPER, 1910. At that time he classified North American eodiscids into 2 families and 8 genera as follows:

1. Eodsicidae including *Eodiscus*, *Calodiscus*, *Dawsonia*, *Weymouthia* and *Serrodiscus*.
2. Pagetidae including *Pagetia*, *Pagetides* and *Dipharus*.

In the same year TEIXIERA erected Delgadellidae in accepting the priority of *Delgadella* WALCOTT, 1912, to *Delgadoia*, *Delgadiscus* and *Alemtejoia* by subjective synonymy. According to him *Lingulepis lusitanica* DELGADO, 1904, the type-species of *Delgadella*, is the pygidium of *Microdiscus souzai* DELGADO,

1904.

In HUPÉ's classification (1953) the eodiscids are schematized into 5 families including 5 subfamilies as follows:

1. Hebediscidae (*Hebediscus, Cobboldia, Triangulaspis*)
2. Weymouthidae (*Delgadoia, Alemtejoia* (i. e. *Pagetiellus*), *Weymouthia*).
3. Pagetidae (*Pagetides, Pagetia, Pagetina*).
4. Eodiscidae
   (1) Caldiscinae (*Calodiscus, Cobboldites*)
   (2) Eodisicinae (*Eodiscus, Serrodiscus,* (i. e. *Paradiscus*)).
   (3) Spinodiscinae (*Spinodiscus, Metadiscus*)
   (4) Brevidiscinae (*Brevidiscus* (i. e. *Calodiscus* ?)).
   (5) Dawsoniinae (*Dawsonia, Deltadiscus*).
5. Aulacodiscidae, nov. (*Aulacodiscus*).

In Treatise (1953), on the contrary, HOWELL accepted only 2 families, namely,

1. Eodiscidae (*Eodiscus, Calodiscus, Dawsonia, Opsidiscus, Serrodiscus, Weymouthia*).
2. Pagetidae (*Pagetia, Delgadoia, Hebediscus, Neocobboldia, Pagetides, Pagetiellus*, ? *Triangulaspis*).

Finally, POKLOVSKAYA's classification in *Principles* (1960) is as follows:

1. Eodiscidae (*Eodiscus, Serrodiscus, Calodiscus, Dawsonia*).
2. Pagetidae (*Pagetia, Pagetides, Triangulaspis, Hebediscus, Dipharus, Neocobboldia, Neopagetia*, nov. (i. e. *Pagetina*), *Pagetiellus, Glabrella*).
3. Opsidiscidae, nov. (*Opsidiscus*).

POKROVSKAYA (1959) added three new genera from Tuwa to the Eodiscina, namely *Ladadiscus* (*L. limbatus* POKR.), *Tannudiscus* (*T. tannuolaicus* POKR.) and *Shiveliscus* (*S. parvus* POKR.) respectively to the Eodiscidae, Opsidiscidae and Pagetidae.

The above review shows the agreement among modern palaeontologists in that the eodiscids consititute a solid group of miomeric trilobites, but they must be classified into 2 or more families. The bipartation by means of the facial suture (1935) which had already been done by WESTERGARD in the sub family rank, and later in the family rank by RASETTI, was applied by HOWELL

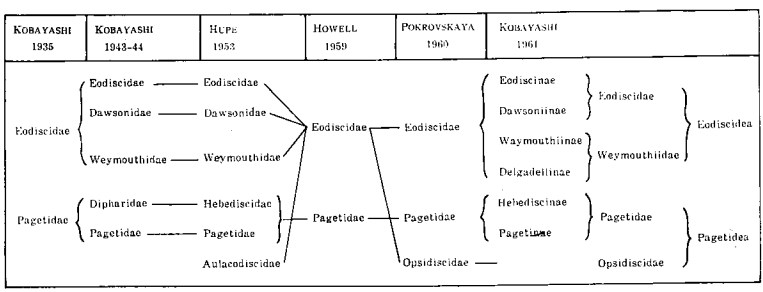


Table. 4. The Classification of the Eodiscina.

in *Treatise* (1959). HUPÉ's classification (1953) which is more detailed, is very similar to mine in 1943. POKROVSKAYA's in *Principles* (1960) may be said intermediate between the two kinds of classification.

Two important facts which I could not bring into consideration in my previous classification are as follows:

1. The Pagetidae have appeared already in the early Cambrian, indicating a parallel to the Eodiscidae, although morphologically they belong to the same major group of trilobites.
2. *Delgadella* and *Opsidiscus* both having a pair of rudimentary eye-spots or turbercles on the cheeks occur in the Lower Cambrian of Portugal and at the top of the Middle Cambrian of Sweden respectively. While the latter is closer to *Pagetia* than any other eodiscids, as WESTERGARD considered it a descent of *Pagetia*, the former is so intimate to *Weymouthia* that R. and E. RICHTER claimed their congenity. In other words, the fusion of cheeks has taken place intermittently on different branches.

With marked contrast with the Agnostina, the glabella or the axial lobe is very stable or invariable in the Eodiscina, but on the basis of the above mentioned facts it can be concluded that the bipartation (1) by the facial suture bears a much higher taxonomic value than the other kinds of division (2). Here my previous classification is emended in the light of the new facts in the following manner.

Superfamily Eodisciacea
  Family Eodiscidae
    Subfamily Eodiscinae (*Eodiscus, Calodiscus, Ladadiscus, Serrodiscus*)
    Subfamily Dawsoniinae (*Dawsonia*)
  Family Weymouthiidae
    Subfamily Weymouthiinae (*Weymouthia*)
    Subfamily Delgadellinae (*Delgadella*)
Superfamily Pagetiacea
  Family Pagetidae
    Subfamily Pagetinae (*Pagetia, Pagetides, Neocobboldia, Neopagetia, Pagetiellus, Shiveliscus*)
    Subfamily Hebediscinae (*Hebediscus*)
  Family Opsidiscidae (*Opsidiscus, Tannudiscus*)

Finally, four eodiscidian species are known from the Lower Cambrian of Central and South China. *Eodiscus chintingshanensis* LU, 1942, having the trilobed conical glabella, tuberculate marginal rim and the multisegmented axis of the pygidium belongs probably to *Serrodiscus*. Because the cephalon is unknown of *Eodiscus tingi* LU, 1942, it is difficult to say its exact generic position. *Hebediscus orientalis* CHANG and *Dipharus spinosus* CHANG were found together in the Shihpai shale. According to CHANG (1953), they are sufficiently different to consider that the latter is not the immature form of the former. The genal and occipital spines are present in the latter, but absent in the former as well as *Dipharus insperatus* CLARK.

Suborder Agnostina SALTER, 1864

Since I had published a monograph on the agnostids and the supplementary notes (1939), many new genera beside the proposals of two new families and two new subfamilies, were erected by LERMONTOVA (1940, 51), RASETTI (1944), LOCHMAN (1944), WESTERGAARD (1946), RUSCONI (1950, 52, 52), IVSHIN (1953), KOBAYASHI (1955), HARRINGTON and LEANZA (1957) and POKROVSKAYA (1958) as follows:

Aspidagnostinae POKROVSKAYA, 1960

Canotagnostidae RUSCONI, 1951

Hypagnostinae IVSHIN, 1953

Rudagnostidae LERMONTOVA, 1951

Baltagnostus LOCHMAN in LOCHMAN and DUNCAN, 1944 (*Proagnostus ? centerensis* RESSER)

Canotagnostus RUSCONI, 1951 (*Canotagnostus huarpeanus* RUSCONI)

Culipagnostus RUSCONI, 1952 (*Culipagnostus chipiquensis* RUSCONI)

Cyclagnostus LERMONTOVA, 1940 (*Cyclagnostus elegans* LERMONTOVA)

Dolichagnostus POKROVSKAYA, 1958 (*Dolichagnostus admirabilis* POKROVSKAYA)

Euplethagnostus LERMONTOVA, 1940 (*Euplethagnostus subangulatus* LERMONTOVA)

Eurudagnostus LERMONTOVA, 1951 (*Eurudagnostus grandis* LERMONTOVA)

Huarpagnostus RUSCONI, 1950 (*Huarpagnostus costatus* RUSCONI)

Hyperagnostus KOBAYASHI, 1955 (*Hyperagnostus binodosus* KOBAYASHI)

Litagnostus RASETTI, 1944 (*Litagnostus levisencis* RASETTI)

Machairagnostus HARRINGTON and LEANZA, 1957 (*Machairagnostus tmetus* HARRINGTON and LEANZA)

Neoagnostus KOBAYASHI, 1955 (*Neoagnostus aspidoides* KOBAYASHI)

Oidalagnostus WESTERGÅRD, 1946 (*Oidalagnostus trispinifer* WESTERGÅRD)

Pentagnostus LERMONTOVA, 1940 (*Pentagnostus anabarensis* LERMONTOVA)

Phalacromina KOBAYASHI, nov. (*Phalacromina minor* KABAYASHI, nov.)

Pseudophalacroma POKROVSKAYA, 1958 (*Pseudophalacroma crebra* POKROVSKAYA)

Pseudorhaptagnostus LERMONTOVA, 1940 (*Pseudorhaptagnostus punctatus* LERMONTOVA)

Quadrahomagnostus CHU, 1959 (*Homagnostus* (*Quadrahomagnostus*) *subquadratus* CHU)

Rudagnostus LERMONTOVA, 1951 (*Agnostus princeps* var. *rudis* SALTER)

Canotagnostus, *Eurudagnostus*, *Huarpagnostus* and *Pentagnostus* were, however, synonymized respectively with *Ptychagnostus*, *Geragnostus*, *Goniagnostus* and *Peronopsis* by HOWELL or POKROVSKAYA. The two authors agree in that *Euplethagnostus* and *Pseudorhaptagnostus* are inseparable from *Pseudagnostus*. According to POKROVSKAYA, *Rudagnostus* is an intimate genus to *Geragnostus*. The subfamily-reference of the remaining genera is suggested below.

Baltagnostus.....Peronopsinae

Culipagnostus .....?
Cyclagnostus .....Agnostinae
Dolichagnostus .....Diplagnostinae
Hyperagnostus .....Geragnostinae
Litagnostus .....Phalacrominae ?
Machairagnostus .....Pseudagnostinae
Neoagnostus .....Agnostinae
Phalacromina .....Phalacrominae
Pseudophalacroma .....Lejopgyinae
Oidalagnostus .....Diplagnosinae
Homagnostus (*Quadrahomagnostus*) .....Agnostinae

The anatomical study made by ÖPIK (1961) on *Glyptagnostus* indicates a new trend of research in the Agnostida. Among others the monograph on the Paradoxidian agnostids of Sweden is of great importance on account of that the country is the classical area for the agnostidian taxonomy. WESTERGAARD (1944) accepted the agnostidian group as a family as he did for the eodiscidian group. According to him, the Diplagnostinae represent an independent evolutional line through the Paradoxidian epoch. The Lejopyginae or *Cotalagnostus* includes the derivatives from the Peronopsinae as well as the Agnostinae stock, but *Lejopyge* is probaly a derivative from the Agnostinae. He contends further that the Phalacrominae may be likewise polyphyletic. Thus he classifies the Paradoxidian agnostids of Sweden into five subfamilies. Their approximate correlation with my subfamilies (1939) is shown below.

WESTERGAARD (1944)	KOBAYASHI (1939)
Condylopyginae	Condylopyginae
Peronopsinae	Peronopsinae
	Spinagnostinae
	Lejopyginae (pars)
Diplagnostinae	Diplagnostinae
	Tomagnostinae
Agnostinae	Ptychagnostinae
	Triplagnostinae
	Agnostinae
	Lejopyginae (pars)
Phalacrominae	Phalacrominae

Bohemia is another important area for the agnostidian taxonomy where PŘIBYL (1953) recognized 7 subfamilies as follows:

Condylopyginae: *Condylopyge, Pleuroctenium*
Peronopsinae: *Peronopsis*
Geragnostinae: *Geragnostus* (*Geragnostus, Geragnostella, Corrugatagnostus*)
Phalacrominae: *Phalacroma*
Leiagnostinae: *Leiagnostus*
Trinodinae: *Trinodus*
Sphaeragnostinae: *Sphaeragnostus*

HUPÉ proposed a scheme of classification (1953) in which 13 families were

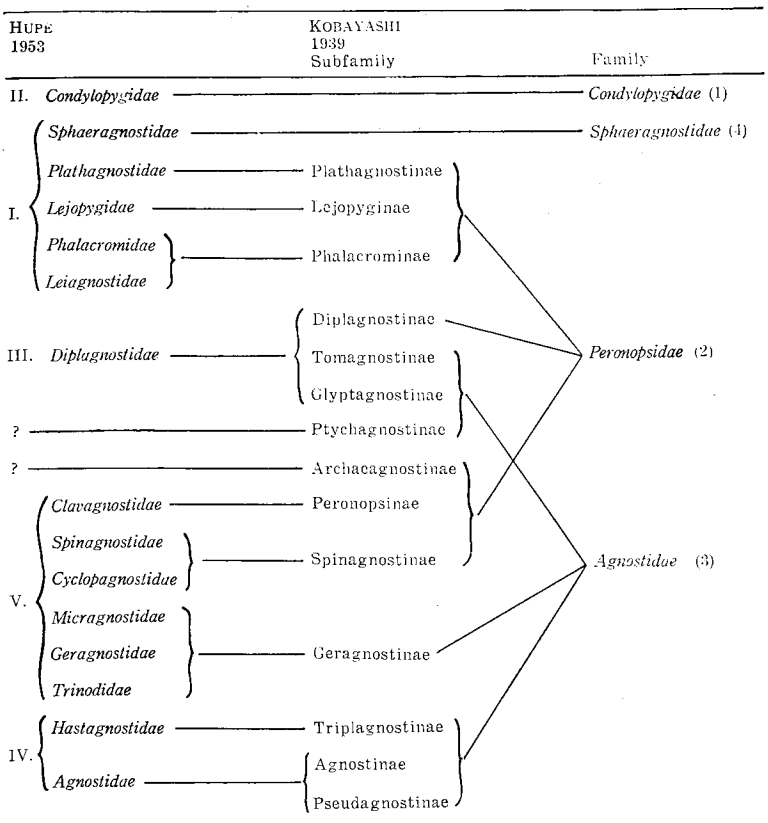


Table 5. The Classification of the Agnostina (I).

combined into five groups as follows:

I. Laevigate agnostids.
II. Agnostids with expanded frontal lobe of glabella.
III. Agnostids with bilobed anterior glabellar lobe.
IV. Agnostids with bisected preglabellar field.
V. Agnostids with fused preglabellar field.

The relation of his families with the families and subfamilies in my classification may be roughly shown in the table 5. Lately HOWELL (1959) and POKROVSKAYA (1960) have accepted respectively 11 families and 13 subfamilies of agnostids. The relation of their taxons with my classification is shown in the table 6.

The above schemes of classification all agree in that the Condylopygidae constitute an isolated group which is characterized by the expansion of the frontal lobe of the glabella. For the other families and subfamilies, however,

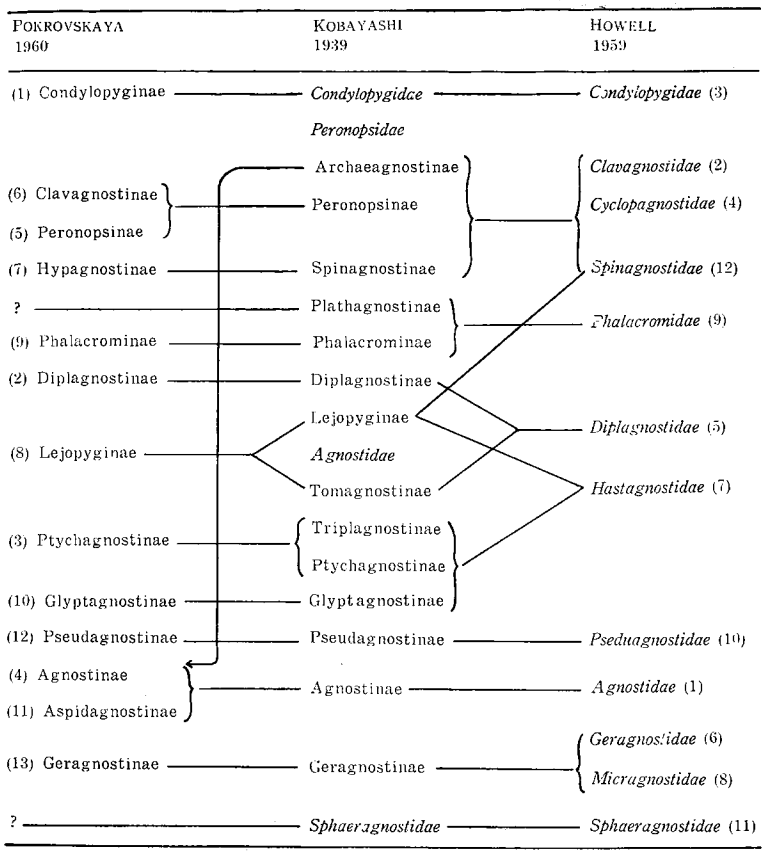


Table 6. The Classification of the Agnostina (II).

the authors disagree with one another.

The bilobation of the anterior glabellar lobe is the characteristic of the Diplagnostidae, but it is often recogized also in the Glyptagnostinae (1949).

The Peronopsidae and the Agnostidae constitute two major groups of the Cambrian agnostids. The Pseudagnostinae represent a specialization of the latter family. It is probable that the Geragnostidae were evolved from the Agnostidae and flourished in the late Cambrian and Ordovician periods.

Laevigate agnostids may be classifiable into the Plathagnostinae, Lejopyginae, Phalacrominae, Leiagnostinae and Sphaeragnostinae. They must be derivatives of non-laevigate agnostids by effacement, but much remains to be studied on their derivation about which from which.

Though still very tentative, an attempt of grouping of families and subfamilies into superfamilies is made in the following manner.

Condylopygacea
Condylopygidae RAYMOND, 1913
Diplagnostacea
Diplagnostidae JAEKEL, 1909 (Diplagnostinae, Tomagnostinae)
? Glyptagnostidae WHITEHOUSE, 1936
Peronopsacea
Peronopsidae WESTERGÅRD, 1936 (Peronopsinae, Clavagnostinae)
Spinagnostidae HOWELL, 1935 (Spinagnostinae, Hypagnostinae, Cyclopagnostinae)
Archaeagnostidae KOBAYASHI, 1939
Phalacromacea
Phalacromidae RAYMOND, 1913 (Phalacrominae, Plathagnostinae)
Agnostacea
Agnostidae M'COY, 1849 (Agnostinae, Aspidagnostinae, Triplagnostinae, Hastagnostinae, Ptychagnostinae)
Pseudagnostidae WHITEHOUSE, 1936
Lejopygidae KOBAYASHI, 1935
Geragnostacea
Geragnostidae HOWELL, 1935 (Geragnostinae, Micragnostinae, Trinodinae)
? Leiagnostidae JAEKEL, 1909
? Sphaeragnostidae KOBAYASHI, 1937

Any further discussion on the grouping is deferred to some other occasion.

Beside the new occurrence of *Ptychagnostus atavus* (TULLBERG) reported by LU, 1957, on the Hunan-Kueichou borderland, 15 new agnostids were discovered in Eastern Asia after 1939 as follows:

cambria KOBAYASHI, 1960, *Geragnostella*
convexus CHU, 1957, *Homagnostus*
corenicus KOBAYASHI, 1960, *Micragnostus*
hisakoshii KOBAYASHI, nov., *Homagnostus*
hunanicus LU, 1957, *Hypagnostus*
lermontovai LU, 1954, *Lotagnostus*
marginisulcatus KOBAYASHI, nov., *Pseudagnostus*
minor KOBAYASHI, nov., *Phalacromina*
nodai ENDO, 1944, *Agnostus*
obsoletus KOBAYASHI, 1960, *Geragnostus*
quadratus LU, 1957, *Hypagnostus*
sinicus LU, 1957, *Ptychagnostus*
subquadratus CHU, 1959, *Homagnostus* (*Quadrahomagnostus*)
taiztuhoensis CHU, 1959, *Homagnostus*
tienshihfuensis CHU, 1959, *Homagnostus* (*Quadrahomagnostus*)

A. nodai is represented by two pygidia which have a large, very broad axial lobe and a long tubercle on it like the pygidium of *Homagnostus* or *Hyperagnostus*. The outline of the pygidium is not ovate as in *Kormagnostus*, but subquadrate as in these two genera. Without the cephalon its taxonomic position is indeterminable.

Family Glyptagnostidae WHITEHOUSE, 1936

Genus *Glyptagnostus* WHITEHOUSE, 1936

Glyptagnostus reticulatus (ANGELIN), 1854

PA1996-9-10
PA1991-9-11
PA1996-9-12
PA 1992002-9-13
PA2000-9-14
PA1993-9-15

Plate IX, Figures 10-15.

1854. *Agnostus reticulatus* ANGELIN, *Pal. Scand*, p. 8, pl. VI, fig. 10.
1867. *Agnostus nodosus* BELT, *Geol. Mag. Vol. 4.* p. 295, pl. 12, figs. 3a-b.
1880. *Agnostus reticulatus* TULLBERG, *Sver. Geol. Unders. Ser. C, No. 42*, p. 23, pl. 1. figs. 12a-b.
1882. *Agnostus reticulatus* BRÖGGER, *Die silur. Etagen 2 u. 3*, p. 57, pl. 1, figs. 112-b.
1906. *Agnostus reticulatus* LAKE, *Brit. Cambr. Tril.* p. 8, pl. 1, fig. 11.
1909. *Ptychagnostus reticulatus* JAEKEL, *Zeitschr. deutsch. geol. Gesell. Bd. 61*, S. 400, Text-fig. 19.
1922. *Agnostus reticulatus* WESTERGÅRD, *Sver. geol. Unders. Ser. Ca, Nio. 18.* pp. 117, 193, pl. 1, figs. 9-11.
1923. *Agnostus reticulatus* POULSEN, *Den. geol. Unders. 2, Raek. No. 140*, p. 76, pl. 9, fig. 5.
1926. *Pseudagnstus reticulatus* BUTTS, *Alabama Geol. Surv. Sp. Rep. 14*, p. 76, pl. 9, fig. 5.
1936. *Glyptagnostus toreuma* WHITEHOUSE, *Mem. Queensland Mus. Vol. 11, Pt. 1*, p. 102, pl. 9, figs. 17-20.
1938. *Glyptagnostus angelini* RERSER, *Geol. Soc. Am. Sp. Pap. No. 15*, p. 49, pl. 10, fig. 23.
1938. *Glyptagnostus reticulatus* KOBAYASHI, *Japan. Jour. Geol. Geogr. Vol. 15*, p. 170, pl. 16, fig. 34.
1939. *Glyptagnostus reticulatus* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 5, Pt. 5*, p. 155, table.
1947. *Glyptagnostus reticulatus* WESTERGÅRD, *Sver. geol. Unders. Ser. C, Nio. 489*, p. 5. pl. 1, figs. 1-6.
1947. *Glyptagnostus reticulatus nodulosus* WESTERGÅRD, *Ibid. Ser. C, Nio. 489*, p. 7, figs. 7-9.
1949. *Glyptagnostus reticulatus* KOBAYASHI, *Japan. Jour. Geol. Geogr. Vol. 21*, p. 1, pl. 1, figs. 1-26.
1958. *Glyptagnostus reticulatus reticulatus* HENNINGSMOEN, *Norsk geol. Tids. Bd. 38, H. 2*, p. 184, pl. 5, fig. 17.
1961. *Glyptagnostus reticulatus* ÖPIK, *Pal. Vol. 3, Pt. 4*, p. 430, pl. 70, fig. 9-11, text-fig. 15.

Cephalon semi-circular in outline; glabella exclusive of basal side-lobes subcylindrical, a little elevated above gently convex cheeks; glabella about a fifth as broad as and three-fifths as long as cephalon and provided with a pair of small triangular side-lobes; glabella itself divided by a transverse furrow into a short anterior and a long posterior lobe; the former usually wider than long and often bisected by a median furrow; the latter divided into three lobes by two pairs of lateral furrows posterior ones of which are especially short and shallow; middle lobe provided with a median tubercle; furrows on cheeks form irregular reticulation on inner side while on the outer they are disposed somewhat radially and increase their number distally by insertion of a short furrow; marginal rim narrow and convex except on posterior side where it is depressed and narrows toward basal side-lobes.

Thoracic segment composed of a broad axial ring and relatively narrow

pleurae; the former bears three round bosses, middle one of which possesses a pair of transversely elongated tubercles; pleura consists of a narrow depressed anterior band and a broad convex elevated posterior band.

Pygidium similar to cephalon in outline and convexity; axial lobe a little broader, conical and three-fourths as long as pygidium; its anterior part divided into three axial rings by two lateral furrows and crossed by a strong axial ridge; posterior part consists of a long anterior and a short depressed posterior portion; pleural lobes ornamented by numerous furrows; reticulation more developed on anterior side; marginal rim narrow; a pair of tiny spines issuing from posterior end of lateral rim.

The above description is chiefly based on the Korean specimens, the largest being about 7 mm. in length. The original variability and the secondary deformation to be seen among the Korean specimens were already described in some length. WESTERGÅRD (1947) and I (1949) have reached independently to the same conclusion that *toreuma* and *angelini* belong to an identical species with *reticulatus*. The erection of *nodulosus* as a subspecies may be worth to designate the local mutation at Scania. Nevertheless, its differences from the typical form in the finer reticulation in the pygidium and bilobation of the basal lobe in the cephalon would not be significant enough for the Korean collection to do so.

Occurrence:—Locs. 241, Ita-1 and Songch'i. Early Olenidian of North Europe; early Upper Cambrian of Australia, British Columbia and Alabama.

Family Peronopsidae WESTERGÅRD, 1936

Genus *Peronopsis* CORDA, 1864

PA3993-3-1
PA3994-3-3
PA3995-3-2.

Peronopsis rakuroensis (KOBAYASHI)

Plate III, Figures 1-3.

1913. *Agnostus chinensis* WALCOTT, pars, *Cambrian Faunas of China*, p. 99, pl. 7, figs. 4, 4a-b, non figs. 5, 5a-c.
1935. *Agnostus rakuroensis* KOBAYASHI, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 103, pl. 14, figs. 17-18,; pl. 21, figs. 1-2, Text-fig.
1937. *Agnostus ozakii* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 159, pl. 30, fig. 7.
1937. *Agnostus comes* RESSER and ENDO, *ibid. Bull. 1*, p. 160, pl. 30, figs. 15-17.
1939. *Peronopsis rakuroensis* KOBAYASHI, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 5, Pt. 5*, p. 189.

Cephalon and pygidium quadrate in outline; glabella bilobed, long posterior lobe carrying a median tubercle; preglabellar median pit often present, but not developed into an axial furrow; axial lobe of pygidium parallel-sided in anterior, conical in posterior, unsegmented or segmentation indicated only by paired pits along axial furrows; marginal border well developed, and provided with a short spine.

The axial lobe is relatively short in the young stage when a short postaxial furrow unites the axial and marginal furrows. In the full grown stage

the lobe is often contracted at about the mid-length.

It is certain that *Agnostus comes* which was proposed for WALCOTT's *chinensis* in fig. 4 is a subjective synonym of *rakurosesis*. It occurs near Chinchiachengtzu, Liaotung, together with *Agnostus ozakii* and *A. egenus*. The monotypic pygidium of *ozakii* is, however, inseparable from that of *comes*. *A. egenus* was proposed for a subcircular form, but gradations from *comes* to *egenus* can hardly be overlooked in fig. 14, RESSER and ENDO, 1937. Therefore *egenus* may be no more than a variety of *comes* i.e. *rakuroensis*. The specific characters of *A. viator* and *A. liaotungensis* are also not distinct. *A. damesi* had the pygidium identical with that of *rakuroensis*, but the preglabellar axial furrow of such strength and length as indicated in figs. 1-2, RESSER and ENDO, 1937, probably prevent the confusion of *dames* with *rakuroensis*. Finally, the cephalon of *Agnostus* cfr. *rakuroensis* from Kashmir, (KOBAYASHI, 1934), disagrees with the typical cephalon of the species in the lack of a median tubercle.

Occurrence:—*Tonkinella* zone at Locs. 104, 105, 109, 201, 296, 304 and 306. Mapanian of Liaotung and coeval formations in Shantung and North Korea.

Family Phalacromidae RAYMOND, 1913

Genus *Phalacromina* KOBAYASHI, new genus

Diagnosis:—Obsolete agnostid having a simple axial lobe and relatively wide side-lobes on pygidium which lacks marginal rims.

Type-species:—*Agnostus nudus ovalis* ILLING, 1916.

Remarks:—The marginal furrow is effaced in this genus, while the axial furrow is obliterated in *Phalacroma*. *Agnostus eskriggei* HICKS, 1872, and *Pseudagnostus extumidus* RAYMOND, 1924, belong to this genus. The below described is a new species.

Distribution:—Late Middle and early Upper Cambrian; Eastern Asia, Europe and North America.

Phalacromina minor KOBAYASHI, new species

Plate IX, Figure 9.

A small pygidium, 1.2 mm. long is semi-oval in outline; its axial lobe a little longer than two-thirds the length and slightly narrower than a half of the pygidium breadth, expanded at middle, rounded at hind, most convex at a point a little anterior to the center and unfurrowed in itself, but clearly outlined by deep axial furrows and elevated above flat side-lobes.

Comparison:—This pygidium is broader than those of *ovalis*, *eskriggei* and *extumidus* and its axial lobe narrower than those of the three allied species. *P. extumidus* is distinct from all others in the possession of a median tubercle and a spine on each side.

Occurrence:—*Hancrania* zone; a boulder at loc. 242.

PA3997-3-12
PA3998-3-13
PA3999-3-14

Genus *Phoidagnostus* WHITEHOUSE, 1936

Phoidagnostus obsoletus (KOBAYASHI)

Plate III, Figures 12-14.

1935. *Agnostus* (*Lejopyge* ?) *obsoletus* KOBAYASHI, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sect. 2, Vol. 4, Pt. 2*, p. 14, fig. 9.
1939. *Lejopyge* ? *obsoletus* KOBAYASHI, *Ibid., Sect. 2, Vol. 5, Pt. 5*, p. 888.

Description:—Cepahlon ovate, moderately convex; glabella well effaced except for basal side-lobes which are still discernible; median tubercle small, located at a point a little posterior to center; posterior border very narrow, but well defined; marginal rim absent. Pygidium more convex than cephalon, provided with a median tubercle near a third from anterior, which is elongated and much larger than that of cephalon; marginal rim thick, convex and separated from main body by a deep groove; axis occupies about a half breadth of pygidium, as can be judged at articulation. Test smooth.

Comparison:—Because the axis is very broad, it is proper to place this species in the Phalacrominae, instead of the Lejopyginae. Because the basal side-lobes are only half way effaced, it must be retained in *Phoidagnostus*.

Phoidagnostus limbatus WHITEHOUSE, 1936, which is the type of the genus, has a subcircular cephalon with a narrow rim of variable width. *Phoidagnostus bituberculatus* (ANGELIN) is intimately related to this species, but the cephalon has no median tubercle but a faint axial ridge in anterior (WESTERGÅRD, 1946).

Occurrence:—*Eochuangia* zone; Locs. 200, 226, 229, 245, 255, 259, 261, 262, 280, 302 and Ita 7.

PA4000-8-1,3,5.
PA4001-8-2,4
PA4002-8-6
PA4003-8-7
PA4004-8-8
PA4005-8-9
PA4006-8-10
PA4007-8-11
PA4008-8-12
PA4009-8-13
PA4010-8-14

Family Agnostidae McCOY, 1849

Genus *Homagnostus* HOWELL, 1935

Homagnostus hisakoshii KOBAYASHI, new species

Plate VIII, Figures 1-14.

Description:—Cephalon subquadrate, but narrowing forward and more or less rounded in front; glabella conical, bilobed, one third as wide as and two thirds as long as cephalon; posterior lobe twice as long as anterior one, carrying a median tubercle; basal side-lobe small, triangular; preglabellar median furrow distinct in posterior half way, but weakened in anterior; marginal border of moderate breadth depressed. Pygidium subquadrate; anterior margin transversal in middle sectant, but a little oblique backward on lateral sides; posterior margin well rounded; axial lobe not large, narrower than a half breadth of pygidium, trilobed, usually contracted at the second lobe carrying a median tubercle; posterior lobe occupying almost a half of axial lobe, rounded at hind, leaving a narrow space inside of posterior border; marginal border as wide as that of cephalon from which a short spine issues on each side.

Observation:—In a complete shield from loc. 197 (fig. 9) the median furrow

is shorter than in the cephalon from Ita 11. It is broader and more or less obscured in some cephala from loc. 313.

In a specimen from loc. 313 (fig. 5) the axial ring of the thorax is seen very broad and bears three bosses. The pleura of the anterior segment is short and directed forward.

An immature pygidium from the same locality (fig. 6) which presumably belongs to this species has a long axial lobe which is remarkably swelling in the posterior and strongly contracted at the second ring. The axial lobe is equally long, but the posterior expansion is reduced in another pygidium in a later stage of growth. In the grown stage the post-axial space is generally seen, unless the pygidium is strongly deformed.

Comparison:—This form best agrees with *Homagnostus obesus* in fig. 4, pl. 1, in WESTERGÅRD, 1922, but in this the glabella is more conical and the marginal borders are more developed on the cephalon as well as the pygidium. The axial lobe of the pygidium is much broader and longer in *Homagnostus hoi* (SUN) and *H. hoiformis* (KOBAYASHI). The preglabellar median furrow is absent in the latter. The former has it, but the median tubercle is located on the anterior, instead of the posterior lobe of the glabella.

Occurrence:—Common at locs. Ita 11, 196, 197 and 313.

PA4011-3-15
PA4012-3-16
PA4013-3-17
PA4014-3-8
PA4015-5-9
PA4016-5-10
PA4017-5-11
PA4018-5-12

Family Pseudagnostidae WHITEHOUSE, 1926

Genus *Pseudagnostus* JAEKEL, 1909

Pseudagnostus primus KOBAYASHI

Plate III, Figures 15–17; Plate V, Figures 8–12.

1935. *Pseudagnostus primus* KOBAYASHI, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sect. 2, Vol. 4, Pt. 2*, p. 108, pl. 14, figs. 6–10.
1939. *Pseudagnostus primus* KOBAYASHI, *Ibid., Sect. 2, Vol. 5, Pt. 5*, p. 158.

The cephala from loc. 313 are all somewhat ovate, nearly as long as broad; tripartation of glabella indistinct; a median tubercle always present on middle section; triangular side-lobes clearly outlined; dorsal, axial and marginal furrows profound. The associated pygidia are also well rounded, devoid of spines; axial and marginal furrows deep and median tubercle prominent. In a pygidium there is a distinct furrow which forms a wide angle behind the tubercle and the posterior pseudolobe clearly outlined by diverging furrows. These furrows are, however, very obscure in another pygidium.

In looking through a large number of cephala in limestones and shales it is found that there is a wide variation in the strength of dorsal and preglabellar furrows, trilobation of the glabella and the prominence of the median tubercle. The one from loc. 200 is a normal form, but the median tubercle is very obscure in another from loc. 271 and most relieves of the cephalon are quite reduced in still another from loc. 273. As suggested by the elongate outline, the effacement of this specimen depends partly on the lateral compression, but the preglabellar furrow which runs in right angle with the trend

of compression is also obsolete. Therefore this furrow must have been originally weak. The primary and secondary variabilities are not so great among the pygidia before hand. They are ovate in outline and invariably lack the spines.

It is a general tendency for the specimens in shale that the marginal border is strongly depressed to form a wide groove, leaving a narrow rim along the periphery.

Occurrence:—*Eochuangia* zone at locs. 200, 204, 245, 255, 260, 261, 262, 273, 280, 281, 292, 293', 301 and 302. Black shale at locs. 196 and 313.

Pseudagnostus marginisulcatus KOBAYASHI, new species

PA4019-3-10
PA4020-3-11

Plate III, Figures 10–11.

Description:—Cephalon and pygidium subquardrate, broader than long, strongly convex, surrounded by very broad and deep furrows and relatively narrow rims. Glabella trilobed, provided with a long median tubercle and a triangular lobe on each side of the base; preglabellar axial furrow narrow and shallow. Anterior axial lobe of pygidium subquadrate, broad, expanded forward and bisegmented; median tubercle elongated through the second segment; second ring furrow forms a wide angle with the posterior end of the tubercle at apex; posterior pseudolobe outlined by a pair of furrows which extend from lateral ends of the second furrow; pleural lobe more or less depressed below axial lobe; short spine issuing diagonally from marginal rim.

Comparison:—*Pseudagnostus orientalis* KOBAYASHI, 1931, i.e. *Pseudagnostus chinensis* (DAMES), 1883, is a close ally to this species, but distinguished by the longer shield of lessend convexity and lack of such pronounced marginal grooves in that species.

Occurrence:—*Eochuangia* zone at Ita 2.

Subclass Polymera JAEKEL, 1909

Order Corynexochida KOBAYASHI, 1935

This order has already been discussed in some details in parts VII and VIII. Its development was much greater in the Pacific than in the Atlantic province.

Family Dorypygidae KOBAYASHI, 1935

Genus *Olenoides* MEEK, 1877

Olenoides manchuriensis ENDO, 1944, from the Taitzu formation in Liaoning has the pygidium more resembling *Kootenia* than *Olenoides* in the single, instead of double ribs on the pleural lobes.

Agyrenella IVSHIN (fig. 14d) bears many aspects common with *Olenoides* except for the axial tubercles and the post-axial sinuation.

PA4021-1-22
PA4022-1-23
PA4023-1-24
PA4024-1-25

Olenoides asiaticus KOBAYASHI, 1935

Plate I, Figures 22–25.

1935. *Olenoides asiaticus* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 154, pl. 14, figs. 10-12, ? 13.

The precise description and comparison of the crandium and pygidium were already given on the previous occasion. The two cranidia from loc. 109 show the occipital spines. In association with these cranidia as well as the pygidia in fig. 25, there is a hypostoma which is thought to belong to this species.

The ovate swell of the hypostoma is provided with the posterior lunate elevation which is separated from the main body by a shallow furrow; marginal rim narrow; anterior border protruded laterally to form a pair of wings.

Occurrence:—*Tonkinella* zone at locs. 109 and 304; *Olenoides* zone of Neietsu.

Family Oryctocephalidae BEECHER, 1897

Subfamily Tonkinellinae REED, 1934

Genus *Tonkinella* MANSUY, 1916

1916. *Tonkinella* MANSUY, *Mém. Serv. géol. l'Indochine, Vol. 5, Fasc. 1*, p. 43.
1934. *Tonkinella* KOBAYASHI, *Am. Jour. Sci. Vol. 27*, p. 299.
1935. *Tonkinella* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 147.
1957. *Tonkinella* LU, *Index Fossils of China, Invert. Vol. 3*, p. 264.
1959. *Tonkinella* RASETTI, *Treatise on Invert. Pal. 0-1*, p. 220.
1960. *Tonkinella* SUVOROVA and TCHERNYSHEVA, *Principles of Pal. Vol. 8*, p. 83.
1961. *Tonkinella* KOBAYASHI, *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 13, Pt. 2*, p. 224.

Diagnosis:—Isopygous Oryctocephalidae without spines on thorax and pygidium; thorax composed of 5 (or 6) segmeuts; pygidium semicircular; its axial lobe relatively short; 5 to 7 flat-topped simple pleural ribs countable on each side of post-axial rib; marginal rim linear.

Type-species:—*Tonkinella flabelliformis* MANSUY, 1916.

Specific list:—

Tonkinella breviceps KOBAYASHI, 1934
Tonkinella kashmirica REED, 1934 (i.e. *T. breviceps*)
Tonkinella quadrifida REED, 1934
(?) *Hundwarella* (?) *remota* REED, 1934, (Pygidium)
Tonkinella stephensis KOBAYASHI, 1935
Tonkinella orientalis KOBAYASHI, 1935
Tonkinella kobayashii RESSER, 1938
Tonkinella idahoensis RESSER, 1939
Tonkinella sibirica TCHERNYSHEVA, 1952, (1960)
Tonkinella shantungensis CHENG, 1959

Remarks:—*Orientalis* is different from *breviceps* in the obsolete furrows on the cranidium; *quadrifida* has a pair of short furrows on the glabella beside three pairs of longer ones behind the short ones. A nearly complete shield is known of *stephensis* in which the thorax is composed of 5 segments (RASETTI, 1951), but *sibirica* may have 6 segments in thorax.

In *flabelliformis* and *shantungensis* there are 5 pleural ribs on each side of

the post-axial rib. *Breviceps* and *stephensis* have one more rib and *sibirica* possesses two more ribs on each side of the post-axial rib. All these furrows on the pygidium are quite effaced in *idahoensis*. In *remota* on the other hand interpleural furrows are present like in the pygidium of *Oryctocare* to which it might belong.

Distribution:—Middle Cambrian; Idaho, West Canada, Siberia, Shantung, South Korea, Yunnan-Tonkin border and Kashmir.

Tonkinella breviceps KOBAYASHI, 1934

1934. *Tonkinella breviceps* KOBAYASHI, *Am. Jour, Sci. Vol. 27*, p. 300, pl. 1, figs. 2–6.
1934. *Tonkinella kashmirica* REED, *Pal. Indica, N. S. Vol. 21, Mem. No. 2*, p. 9, 37, figs. 2–8. ? 9.

As pointed out by REED in the postscript of his memoir, *T. kashimirica* is certainly synonymous with *T. breviceps* from Kashmir.

(pl.2, fig.15 とついでに)

PA4025-1-3 PA4026-1-4

Tonkinella kobayashii RESSER, 1938

Plate I, Figures 3–4.

1935. *Tonkinella breviceps* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 150, pl. 15, figs. 6, 8–9.
1938. *Tonkinella kobayashii* RESSER, *Smiths. Misc. Coll. Vol. 97, No. 10*. p. 43.

RESSER proposed this specific name for *T. breviceps* from South Korea without giving any specific distinction. This species is different from the preceding in the pitted lateral furrows on the glabella of which the middle and posterior pairs are confluent on the axis, comparatively narrower fixed cheeks and punctate test, instead of fine granulose or smooth test in the preceding. The pygidia of these two species are almost identical with each other.

Occurrence:—*Tonkinella* zone at locs. 105, 109, 293, 304, 306 and Ita 10; *Olenoides* zone of Neietsu.

Family Dolichometopidae WALCOTT, 1916

Genus *Amphoton* LORENZ, 1906

Amphoton deois (WALCOTT), 1905

PA4027

Plate X, Figure 13.

1905. *Dolichometopus deois* WALCOTT, *Proc. U. S. Nation. Mus. Vol. 29*, p. 94.
1942. *Amphoton deois* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sect. 2, Vol. 6, Pt. 10*, p. 175. (See for synonymic references.)

Occurrence:—Two cranidia collected by SAITO from the Rinson shale in the north of Chunghwa, P'yŏngan-namdo are referable to this species. It was originally described from the lower Changshan or Tangshihan of Shantung and Tschanghsingtau, at the neck of the Liaotung peninsula, China and later reported to occur in Ch'osan (Sosan) area in North Korea (1935).

Family Damesellidae KOBAYASHI, 1935

Subfamily Tingocephalinae HUPÉ, 1953

Genus *Tingocephalus* SUN, 1935

Tingocephalus concavolimbatus (ENDO), 1937

Plate X, Figure 5. PA4028

1937. *Parakoldinioidea concavolimbatus* ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 330, pl. 70, figs. 20-21.

1960. *Tingocephalus concavolimbatus* KOBAYASHI, *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 12, Pt. 2*, p. 357.

Occurrence:—Daizanian at Tschanghsingtau, Liaoning.

Family Leiostegiidae BRADLEY, 1925

Subfamily Eochuangiinae KOBAYASHI, 1935

Genus *Eochuangia* KOBAYASHI, 1935

Eochuangia hana KOBAYASHI, 1935

Plate V, Figures 15a-b, 16, 17. PA4029-5-15 PA4030-5-16 PA4031-5-17

1935. *Eochuangia hana* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 183, pl. 16. figs. 10-17.

Occurrence:—This is widely distributed in the *Eochuangia* zone at locs. 111, 204, 225, 227, 261, 262, 273, 287 and 302.

Eochuangia hana subsp. *conica* KOBAYASHI, 1935

Plate VII, Figures 8-14. PA4032-7-8 PA4033-7-9,10 PA4034-7-11 PA4035-7-12,13 PA4036-7-14

1935. *Eochuangia hana* var. *conica* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sect. 2, Vol. 4, Pt. 2*, p. 184, pl. 16, figs. 7-9.

The conical outline of the glabella, relatively small eyes and erected sharp frontal rim are the significant features of this glabella. The frontal groove is more profound in this subspecies than the typical form. The free cheek has a genal spine which extends more laterally than the lateral margin of the cheek. Compared to typical *hana*, the pygidium is somewhat shorter; its pleural rib rounded on the top and the interpleural furrow weak or obsolete. A pygidium in fig. 11 has the axial spine which is unusually flattopped.

An associated thoracic segment has a broad axial ring; pleuron bent back almost rectangularly and prolonged into a spine; pleural groove strong and running into a spine.

Two larval cranidia contained in the collection from loc. 196, are both trapezoidal in outline. One in fig. 12 is relatively long and its glabella divided into lobes. The other in fig. 13 is broader; its glabella more or less expanded forward and separated from the erected frontal rim by a relatively large de-

pression; dorsal and occipital furrows are distinct, but no lateral furrows exist; fixed cheek rolled up; eyes apparently small and located at about a third the length behind the frontal rim and connected with glabella by a ridge.

Occurrence:—Black shale at locs. 196 and 199.

Family Pagodiidae KOBAYASHI, 1935

Subfamily Pagodiinae KOBAYASHI, 1935

Genus *Lisania* WALCOTT, 1911

Lisania conica KOBAYASHI, new species

PA4037-5-3 (4) V

PA4038-5-4

Plate V, Figures 3-4.

Cranidum with long conical unfurrowed glabella, well defined neck ring which is thickened toward the axis, narrow fixed cheeks and medium sized eyes. Eye-ridges are present. The long glabella is separated from the convex frontal border by a deep furrow; facial sutures slightly divergent anterior to the eyes.

A pygidium procured from the same locality with the cranidium is very broad and somewhat sinuated behind the axis; only the first segment well defined by deep furrows; axis short, conical, elevated above flat wide pleural lobes; marginal rim narrow. Its reference to this species is, however, provisional.

Occurrence:—*Eochuangia* zone at loc. 274.

Family Komaspididae KOBAYASHI, 1935

Because I have discussed this family in 1954 in a great detail, only sundry notes are added here.

1. LOCKMAN-BALK included (1959) *Chariocephalus* and *Drumaspis* with *Elvinia*, *Maladioides* and *Taishania* in the Elvinidae, but it can hardly be overlooked that the former two genera are quite distinct from the others in the undeveloped preglabellar area which is the characteristic feature of the Komaspididae.

2. As HUPÉ (1953) placed the Ellipsocephaloidae at the next place of the Komaspididae, the eyes are well developed, while the preglabellar area is much reduced in *Ellipsocephaloides*, although the spiny associate pygidium requires its separation from the Komaspididae at least in the family rank. The difference is however, by no means greater than that seen between the pygidia of *Bonnia* and *Holteria* in the Dorypygidae.

3. In the Hwangho basin the family is represented by *Irvingella taitzuensis* LU, 1957, from the Changshanian of Liaoning.

4. *Carolinites* which is known from the Ordovician (Canadian and Chazyan) in Tasmania, Nevada and Ireland is an interesting example of discontinuous distribution. *Keidelia macrophthalma* HARRINGTON and LEANZA, 1957, from the Llanvirnian *Proetiella tellecheai* zone of Argentina which was first referred to the Proetidae by the authors, agrees with *Carolinites* in the large bulbous

glabella provided with a pair of basal lobes, large eyes, straight frontal rim and a median tubercle bearing axial ring of the pygidium so nicely that it is now included in that genus. Taking this occurrence as a link, it is presumed that the genus has taken the southern Pacific route for migration.

Genus *Komaspis* KOBAYASHI, 1935

Subgenus *Parairvingella* KOBAYASHI, 1938

Komaspis (*Parairvingella*) *convexus* KOBAYASHI, 1935

PA4039-2-22
PA4040-4-1
PA4041-4-2

Plate II, Figure 22, Plate IV, Figures 1-2.

1935. *Komaspis* (?) *convexus* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 142, pl. 16, fig. 3.

1954. *Komaspis* (*Parairvingella*) *convexus* KOBAYASHI. *Japan. Jour. Geol. Geogr. Vol. 24*, p. 34, pl. 6, figs. 11a-b.

This species has already been described in detail. As shown in two figures in this paper, the convexity of the cranidium and the proportional size between the glabella and fixed cheek vary to some extent, even among the cranidia from the same locality.

Occurrence:—*Eochuangia* zone at locs. 225, 262, 273, 281 and 301.

PA4042-8-17
PA4038-8-19
PA4043-8-18
PA4044-8-20
PA4045-8-21
PA4046-8-22

Komaspis (*Parairvingella*) *megalops* KOBAYASHI, new species

Plate VIII, Figures 17-22.

Description:—Cephalon exclusive of spines subelliptical; glabella long, conical or ovate, rounded in front; posterior lateral furrows confluent on the axis; occipital furrow transversal; posterior margin of cranidium somewhat turning forward near the lateral ends; eye-bands large, nearly as long as glabella exclusive of neck ring; preglabellar area divided into a limb and rim, the latter of which is straight and elevated, while the former is depressed; fixed cheek widening posteriorly. Free cheek very narrow; long genal spine issuing from the middle of lateral border and extending far back. Facial suture very short, its anterior branches being subparallel to the axis and its posterior one extending diagonally from the rear end of the eye. Test apparently smooth.

Observation:—In the associated thoracic segments the axial ring is convex and relatively broad and the pleuron parallel-sided on the proximal side, but on the distal one-third it narrows abruptly till it is pointed laterally at the extremity. The pygidium is broad and semicircular; axis short, cylindrical and elevated above flat pleural lobes. The first axial ring and the first pleural rib are clearly defined by furrows; marginal rim narrow. Because all specimens are depressed in shales, the original convexity of the shield is unknown.

Comparison:—The long slender glabella, weak posterior furrow and straight relatively long frontal rim are very distinctive of this species. In *K.* (*P.*) *convexus* the glabella is shorter and more rounded and the posterior glabellar furrow as strong as the occipital one.

Occurrence:—Black shales at locs. 196, 199 and 313.

Family Dinesidae LERMONTOVA, 1940

Among the Dinesidae, Tollaspidae and Proerbidae there was some confusion in terminology. Here the group of trilobites is classified in the following manner.

Family Dinesidae LERMONTOVA, 1940, characterized by isolated basal sidelobes and diagonal preglabellar furrows.

Subfamily Dinesinae LERM. 1940, (i. e. Dinesidae HUPÉ 1953) including dinesids in which the preglabellar boss is undeveloped; Middle Cambrian of Australia; (?) Lower Cambrian of Siberia.

Dinesus ETHERIDGE, 1896, (*Dinesus ida* ETHERIDGE).

? *Botomella* SUVOROVA, 1958, (*Botomella ekaterinae* SUVOROVA, Fig. 14a-b).

Subfamily Tollaspinae KOBAYASHI, 1941, (i. e. Proerbiidae HUPÉ, 1953) including tollaspids in which the preglabellar boss is usually developed; Lower and Middle Cambrian of Siberia.

Tollaspis KOBAYASHI, 1935, (*Anomocare pawlowski* SCHIMIDT).

Erbia LERM. 1940, (i. e. *Paratollaspis* KOBAYASHI, 1941) (*Cyphaspis sibirica* SCHIMIDT).

Proerbia LERM. 1940, (*Proerbia prisca* LERM. Fig. 14c).

Dinesus was first referred to the Asaphidae by GREGORY (1903). Subsequently, the genus was located in the Dolichometopinae (KOBAYASHI, 1935) and the Ellipsocephalidae (WHITEHOUSE, 1939). Still later the Dinesidae (plus Proerbiidae) were placed in the Corynexochoidae (HUPÉ, 1953), the Corynexochida (Treatise, 1959) and in the Solenopleuroidae, (Principles, 1960). From majority of the different opinions it can be recognized that the Dinesidae bear certain features of the Corynexochidean affinity, but the family is by no means diagnostic of the order. Because only the cranidia are known of the Tollaspinae, the final decision must await the finding of their complete carapaces, but the Dinesinae are certainly close to the Corynexochida.

Incidentally, *Tollaspis quartus* MOKSIMOVA, 1955, from the Lower Ordovician disagrees with *Tollaspis pawlovskii* (SCHMIDT), in the lack of the preglabellar boss. In the protrusion of the glabella into the frontal border, it coincides with *Inouyina*, but it differs again from *Inouyina* in the relatively long cranidium, broader and more conical glabella provided with 3, instead of 4, pairs of lateral furrows and much narrower fixed cheeks and the thicker frontal border. Its nearest ally which I think of is *Hystricurus convexus* ENDO, 1935, from the Middle Ordovician of South Manchuria for which I have created *Endocrania* (1956). At that time I have referred this new genus to the Kaolishaniinae, but later I found the Calymenidae for its proper family reference (1960). In my opinion *Tollaspis quartus* belongs to *Endocrania*, if not to *Ptychometopus*.

Family Telephinidae MAREK, 1952

Genus *Telephina* MAREK, 1952

(*Telephus* BARRNDE, 1852, non GISTEL, 1848)

The distribution of the genus had long been restricted to the Atlantic province from Europe to eastern North America until *Telephus pacificus* was found in British Columbia (1955). Subsequently two new species, *Telephus chinensis* and *T. angulatus*, were described by YI (1957) from the Caradocian of the Yangtze gorge, Central China. Therefore *Telephina* may be a cosmopolitan genus, although it is as yet uncovered in Australia and South America.

Order Ptychopariida SWINNERTON, 1915

Suborder Ptychopariina RICHTER, 1933

Family Ptychopariidae MATTHEW, 1887

Ptychoparioids are one of the most difficult groups to classify. I do not intend here to discuss the group very far, but I wish to touch with some Asiatic genera.

In Siberia *Ptychoparia magna* TCHERNYSHEVA and *Elrathia alexandrovi* TCHERNYSHEVA (1960) are two representatives of *Ptychoparia* and *Elrathia*. The former reveals close resemblance to *Ptychoparia striata*. The latter bears some alliance with *Elrathia* on one side and with the Solenopleuridae on the other. Its cranidium is, however, fairly ptychoparioid and certainly much broader than that of *Elrathia kingi*.

Kounamkites LERMONTOVA in POLETAYEVA and TCHERNYSHEVA, 1956, (Fig. 2g) and *Jangudaspis* OGIENKO, 1956, are two of Siberian genera referred to the Ptychopariidae. The type-species of the respective genus is *K. virgatus* TCHERNYSHEVA or *J. princeps* OGIENKO. The thorax of *princeps* has 12 to 13 segments. Its cranidium is subcylindrical, subrounded in front and provided with distinct lateral furrows; eyes small and located far anteriorly and eye-ridge wide, distinct and nearly horizontal; frontal limb convex and frontal rim wire-like; facial sutures short and subparallel anterior to eyes and long and diagonal posterior to them. It bears some alliance to *Pianaspis*, which is a papyriaspid.

Kounamkites looks more related to *Anomocarella* than *Ptychoparia* in the general aspects of the cranidium and glabella, but it possesses nerve-like lines on the frontal limb. On these accounts it is comparable to *Luia*, but the glabellar furrows are obsolete in *Kounamikites*.

Binodaspis LERMONTOVA 1951, is a small ptychoparioid having a truncato-conical roof-shaped glabella, 3 or 4 short lateral furrows, a median tubercle or spine on neck ring, relatively small eye near the center of the cheek and radially striated convex preglabellar field; test tuberculate. A peculiar round node at the junction of the eye-ridge with the eye-band, is a unique feature of this genus.

The type-species is *Binodaspis spinosa* LERM. from the late Lower Cambrian on the Lena river, Siberia. Now it includes 3 additional species and the complete shield is known of *B. paula* SUVOROVA (1960) whose thorax has 15 segments. She referred it to the Antagminae of the Ptychopariidae. *Lermontoviella shanganica* POKROVSKAYA (1959) from the Lower Cambrian of Tuwa is another new member of the subfamily. They are all similar to *Proliostracus* in some features or others.

Bolaspidina insignis LERMONTOVA in TCHERNYSHEVA, 1960, from the Middle Cambrian of the Olenek region is the monotypic species of the genus which was denominated in favor of its affinity to *Bolaspis* and referred to the Alokistocaridae. The glabella and cranidium are however, not so triangular as in *Bolaspis*, but bear ptychoparioid aspects. The median boss in the preglabellar area is in this genus so distinct and circular as in *Nepeia*.

Finally, *Gaphuraspis* IVSHIN, 1957, is a ptychoparioid genus comprising three early Middle Cambrian species of Kazakstan among which *G. kalievi* IVSHIN is the type-species. Only the cranidium is known of the genus which is remarkably similar to those of *Ptychoparia mantoensis* WALC., *P. constricta* WALC. and *P. impar* WALC. in general aspects, notably in the unfurrowed glabella, size and position of the eyes and subparallel anterior sutures. It was compared with *Pachyaspis* by IVSHIN, but the glabella is relatively long in *Pachyaspis*. *Gaphuraspis* was erected by IVSHIN as a member of the Ptychopariidae, but in my opinion it may be more properly located in the Emmrichellidae.

In Eastern Asia there are many species referred to *Ptychoparia* and *Elrathia* which are revised in the following pages. In addition, there are two species in two other genera and they are *Proliostracus* (?) *brevicaudatus* SAITO and SAKAKURA, 1936, (Fig. 2a) and *Elrathiella taira* KOBAYASHI, 1961.

Furthermore many ptychoparioids were described by REED (1910) from Spiti, but any comment is deferred to some other occasion.

Genus *Ptychoparia* HAWLE and CORDA, 1847

The genus, *Ptychoparia*, is here understood as a comprehensive genus merging with *Ptychoparella* POULSEN, 1927, and *Lyriaspis* WHITEHOUSE, 1939. Generally it has a broad cranidium, truncatoconical glabella, nearly as wide as the fixed cheek through eyes, large, broad preglabellar field which is never concave and often striated radially and irregularly and the raised marginal border whence a genal spine usually issues.

In *Elrathia* and *Elrathiella* the cranidium is narrower or longer and in *Elrathia kingi* its outline is typically contracted at eyes. It can be readily distinguished from *Alokistocare* and its allies by their preglabellar concavity and the median elevation or depression of the preglabellar field. Though still tentative, a synoptic list of Eastern Asiatic species is given below.

Original specific name	Present determination
acilis WALCOTT, 1905, *Ptychoparia*	*Ptychoparia*
batia WALCOTT, 1905, *Ptychoparia* (?)	*Chuangia* (type)
bipuncta KOBAYASHI, 1961, *Ptychoparia*	*Ptychoparia*
bromus WALCOTT, 1905, *Ptychoparia* (?)	*Changshania*
burea WALCOTT, 1905, *Ptychoparia* (*Proampyx*)	*Changshanocephalus*
ceus WALCOTT, 1905, *Ptychoparia*	*Liostracina krausei*
chengshanensis SUN, 1924, *Ptychoparia* (*Emmrichella*)	*Emmrichella*
comus WALCOTT, 1906, *Ptychoparia*	*Anomocarella*
constricta WALCOTT, 1905, *Ptychoparia*	*Gaphraspis* (?)
coreanica KOBAYASHI, 1935, *Ptychoparia* (?)	*Ptychoparia*
dispar ENDO, 1937, *Ptychoparia* (?)	*Mapania* (?)
dryope WALCOTT, 1905, *Ptychyparia*	*Wuhuia*
fengtiensis ENDO, 1944, *Ptychoparia*	?
fongi SUN, 1924, *Ptychoparia*	*Ptychoparia* (?)
grabaui RESSER and ENDO, 1937, *Ptychoparia* (?)	*Proasaphiscus angustilimbatus*
granosa WALCOTT, 1911, *Ptychoparia*	*Ptychoparia*
granulosa WALCOTT, 1905, *Ptychoparia*	*Ptychoparia granosa*
impar WALCOTT, 1905, *Ptychoparia*	*Gaphuraspis* (?)
impar var. by WALC. 1905, *Ptychoparia*	*Annamitia* (?) *yenchonensis* (RESSER) 1942
inflata WALCOTT, 1906, *Ptychoparia*	*Lorenzella*
intermedia WALCOTT, 1906, *Ptychoparia* (*Liostracus*)	*Solenoparia*
kochibei WALCOTT, 1911, *Ptychoparia*	*Ptychoparia*
leichuangensis SUN, 1924, *Ptychoparia*	Anomocarellinae (?)
ligea WALCOTT, 1905, *Ptychoparia*	*Probowmania* (type)
lilia WALCOTT, 1906, *Ptychoparia*	*Solenoparia*
maia WALCOTT, 1906, *Ptychoparia* (?)	*Saimachia* (?)
mantoensis WALCOTT, 1905, *Ptychoparia*	*Gaphraspis* (?)
nereis WALCOTT, 1906, *Ptychoparia*	*Metanomocarella*
orientalis KOBAYASHI, 1935, *Ptychoparia*	*Ptychoparia*
subgrugosa WALCOTT, 1906, *Ptychoparia* (*Liostracus*)	*Grandioculus*
szechuanensis SUN in LU, 1939, *Ptychoparia*	*Yühsienszella* (type)
tellus WALCOTT, 1905, *Ptychoparia*	*Annamitia* (?)
tenes WALCOTT, 1905, *Ptychoparia*	*Anomocarella*
tenuicaudata ENDO, 1937, *Ptychoparia*	*Amecephalus*
theano WALCOTT, 1905, *Ptychoparia*	*Emmrichella* (type)
thraso WALCOTT, 1905, *Ptychoparia* (*Liostracus*)	*Grandioculus*
titiana WALCOTT, 1905, *Ptychoparia*	*Paragraulos*
tolus WALCOTT, 1905, *Ptychoparia*	*Solenoparia* (?)
toxeus WALCOTT, 1905, *Ptychoparia* (*Liostracus*)	*Solenoparia* (type)
trogus WALCOTT, 1905, *Ptychoparia* (*Liostracus*)	*Peishania* (?)
tschanghsingensis ENDO, 1937, *Ptychoparia*	*Luia*

tutia WALCOTT, 1905, *Ptychoparia* (*Liostracus*) .....*Semispharocephalus*(?)
typus (DAMES) by WALCOTT, 1913, *Ptychoparia* .....*Mapania* (type)
undata WALCOTT, 1906, *Ptychoparia*.....*Metanomocarella*
vesta WALCOTT, 1906, *Ptychoparia*.....*Anomocarella*
yohi SUN, 1924, *Ptychoparia* .....Anomocarellinae (?)
yunnanensis MANSUY, 1912, *Ptychoparia* .....*Yunnanocephalus* (type)

Among WALCOTT's 8 species of *Ptychoparia* (1913), *P. typus* and *P. ligea* were selected respectively for the type-species of *Mapania* and *Probowmania*. *Lilia* is most probably a *Solenoparia* and *tolus* may be a member of the Solenopleurinae. As noted elsewhere, *impar* bears some resemblances with *Gaphuraspis*, while it is noteworthy that *impar* var. looks similar to *Annamitia*, although the occipital spine is absent or unpreserved on the specimen. RESSER (1942) is incorrect to transfer *granosa* together with SUN's *fongi* into *Probowmania*, because their glabellae are broad and truncato-conical. It is more likely for SUN's three species (*fongi*, *leichuangensis* and *yohi*) to be anomocarellids.

According to ENDO (1944) RESSER and ENDO's Shihchiaoan three species, 1937, i.e. *Ptychoparia orientalis*, *Elrathia manchuriensis* and *Manchuriella prisca* belong to a single species of *Ptychoparia* where the third is an abraded specimen. In one of the specimens (fig. 7, pl. 20, 1937) the thorax is said to consist of 11 segments. My question is attached to the three cranidia in fig. 11, pl. 20, having the very large palpebral lobes which are united with the glabella by the well developed eye-ridges. They look very much like protolenids, although the other cranidia of *orientalis* are ptychoparioids.

Ptychoparia fengtiensis is another Shihchiaoan species whose description and illustration are, however, too imperfect to grasp its specific concept.

ENDO (1944) identified Tangshihan *Manchuriella angustilimabata* RESSER and ENDO with Mapanian *Ptychoparia* (?) *grabaui*. I agree with him in uniting them into a species, but I would identify the latter with the former species because they look an anomocarellid which should be called a *Proasaphiscus* or a *Szeaspis*.

Ptychoparia kochibei WALCOTT, 1911

PA 40047 - 10 - 1, 2.
PA 40048 - 10 - 3, 4.

Plate X, Figures 1-4.

1911. *Ptychoparia kochibei* WALCOTT, *Smithsonian Misc. Coll. Vol. 57, No. 4*, pp. 78, pl. 14, figs. 10, 10a.
1913. *Ptychoparia kochibei* WALCOTT, *Cambrian Faunas of China*. p. 132, pl. 12, figs. 5, 5a-e.
1935. *Ptychoparia kochibei* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 225, pl. 24, fig. 24.
1937. *Ptychoparia kochibei* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 275, pl. 32, figs. 14-16, 18-19, pl. 33, figs. 18-21.
1957. *Ptychoparia kochibei* LU, *Index Fossils of China, Invertebrates, Vol. 3*, p. 266, pl. 141, fig. 16.

The cranidium in fig. 5c, pl. 12, WALCOTT, 1913, is RESSER and ENDO's

lectotype of this species. Among the specimens in shale slabs at hand the glabellar furrows are reduced in strength. In two cranidia the frontal rim is as convex as in the lectotype, but it is depressed and flattened in another. The radial striations are very much obsolete in these specimens. Nevertheless they can safely be identified with this species.

Occurrence:—The type locality is in the Fuchou series of Tschanghsingtau. The above specimens came from North of Maochiakou (毛家溝) (loc. 41), Wuhutsui, Liaoning. It occurs also in Ch'osan (Sosan) area in North Korea.

Ptychoparia orientalis RESSER and ENDO, 1937

Plate XI, Figure 13. V PA4049

1937. *Ptychoparia orientalis* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 276, pl. 20, figs. 7-13.
1937. *Elrathia manchuriensis* RESSER and ENDO, *Ibid.* p. 218, pl. 20, fig. 6.
1937. *Manchuriella prisca* RESSER and ENDO, *Ibid.* p. 248, pl. 20, fig. 4.
1944. *Ptychoparia orientalis* ENDO, *Bull. Central Nat. Mus. Manch. 1*, p. 73.

Description:—Ptychoparioid having broad fixed cheeks, large eyes located far posteriorly and very long genal spines; glabella truncato-conical, outlined by deep dorsal furrows, two-thirds as long as cranidium, provided with three pairs of lateral furrows and an occipital furrow; neck ring thickened mesially; eye about half as long as cheek at eye, moderately arcuate and connected with frontal lobe of glabella by nearly transversal eye-ridge; fixed cheek as wide as occipital ring; frontal limb and rim both convex, separated from each other by marginal furrow; free cheek narrow; anterior facial sutures slightly divergent and posterior ones short, nearly diagonal. Thorax composed of 11 (?) segments; axial ring nearly as wide as pleuron; pleural groove fairly strong; pleuron pointed at lateral end.

Observation and comparison:—Neither a diagnosis nor a precise observation was given by the authors. Nevertheless, a specimen from Shihchiao stage in the east of Liaoyang is most probably identifiable with this species through the agreement of the major characters. One difference is the frontal rim more inflated in the Shihchiaotzu form. The present specimen is composed of a cranidium and 10 thoracic segments. A Shihchiaotzu specimen of provisional identification has 11 segments in thorax.

Ptychoparia striata with which the authors made comparison appears to me fairly different from this in the much broader fixed cheeks, especially the lateral development of the posterior limb, smaller eyes at more anterior position and distinct ptychoparian striation which is however, obscure either in the authors' specimens or mine.

If *Elrathia manchuriensis* is correctly referred to the genus, it must be the oldest member of *Elrathia*, but as the authors noted, its wide fixed cheek is an unmistakable distinction from *E. kingi*. Although no comparison was made, it agrees with *P. orientalis* so nicely that their specific identifity is hardly deniable. Because the two species are contained in the same shale of

Shihchiaotzu on the Antung-Mukden line and the fossils fairly distorted, minor differences are attributable to secondary deformation.

Occurrence:—Shihchiaoan reddish shale at Peihsüehmei (北雪梅), east of Liaoyang; pale green shale near Shihchiaotzu on the Antung-Mukden line, and 7 miles southeast of Liaoyang.

Ptychoparia coreanica KOBAYASHI, 1935

Text-figure 2f.

1935. *Ptychoparia* (?) *coreanica* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 226, pl. 23, figs. 3-4.

Ptychoparia orientalis is a campanion species of *coreanica* which also has 11 segments in thorax. The latter species can be distinguished from the former by the striking contraction of the cranidium at eyes and wide divergence of the sutures therefrom. The anterior outline of the glabella is somewhat rounded in *coreanica*, but straight and transversal in *orientalis*.

Occurrence:—Rinson shale of Chunghwa or Chuwa area, North Korea.

PA4050-1-14
PA3989-1-15
PA4051-1-16
PA4052-1-17
PA4053-10-8

Ptychoparia bipuncta KOBAYASHI, new species

Plate I, Figures 14–17, Plate X, Figure 8.

1935. *Kogenium rotundum* (cranidium only) KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 275, pl. 17, fig. 6, only.

1935. *Manchuriella* cfr. *convexa* KOBAYASHI, *Ibid.* p. 299, pl. 17, fig. 20.

Description:—Glabella strongly convex, nearly as long as wide, conical, truncated in front; dorsal and occipital furrows profound, considerably pitted at lateral ends of frontal margin; three pairs of lateral furrows present, posterior ones of which are diagonal and deepest; neck ring greatly thickened mesially; palpebral lobes relatively small, opposed at mid-length of cranidium; eye-ridge narrow and fairly oblique; fixed cheeks at eyes as wide as glabella measured at anterior, gently convex except for the postero-lateral limb which is steeply slant; frontal limb twice broader than frontal rim, which the latter is strongly convex and distinctly elevated above the former; frontal groove deep; anterior facial sutures subparallel and posterior ones diagonal.

Comparison:—In the vaulting of the glabella this cranidium reveals some resemblance with that of *Solenoparia*, but its outline is certainly ptychoparioid, like WALCOTT's *Ptychoparia aclis* and *P. ligea* for example. A nuchal spine is present and the suture intramarginal through the frontal rim in *aclis*. In *ligea* the fixed cheeks are much broader in relative to the narrow glabella. A pair of strong pits at the antero-lateral angles of the glabella represent a characteristic of this species. No trace of nerve-like lines are seen on the frontal limb. Granules are sparse on the cranidium in fig. 15 and totally absent on the holotype.

In the pair of anterior pits and some other characteristics this species

agrees with *Ptychoparia talingensis* (DAMES), (KOBAYASHI, 1937). The glabella is much wider in *talingensis* than in *bipuncta*.

The cranidium once referred to *Kogenium rotundum* belongs to this species. It is also probable for the pygidium of *Manchuriella* cfr. *convexa* to go with this kind of cranidium, because they are found together and have both strongly convex marginal rims.

Occurrence:—*Tonkinella* zone at locs. 109 and Nei 2.

Genus *Elrathia* WALCOTT, 1924

1924. *Elrathia* WALCOTT, *Smithsonian Misc. Coll. Vol. 75, No. 2*, p. 56.
1925. *Elrathia* WALCOLT, *Ibid. Vol. 75, No. 3*, p. 87.
1935. *Elrathia* RESSER, *Ibid. Vol. 93, No. 5*, p. 27.
1944. *Elrathia* SHIMER and SHROCK, *Index Fossils of N. Am.* p. 611.
1953. *Elrathia* HUPÉ, *Ann. de Pal. tom. 39*, p. 128.
1959. *Elrathia* HOWELL, *Treatise on Invert. Pal. O-1.* p. 240.
1960. *Elrathia* BALASHOVA, IVSHIN and TCHERNYSHEVA, *Principles of Pal. 8*, p. 105.

Type-species:—*Conocoryphe* (*Conocephalites*) *kingi* MEEK, 1870.

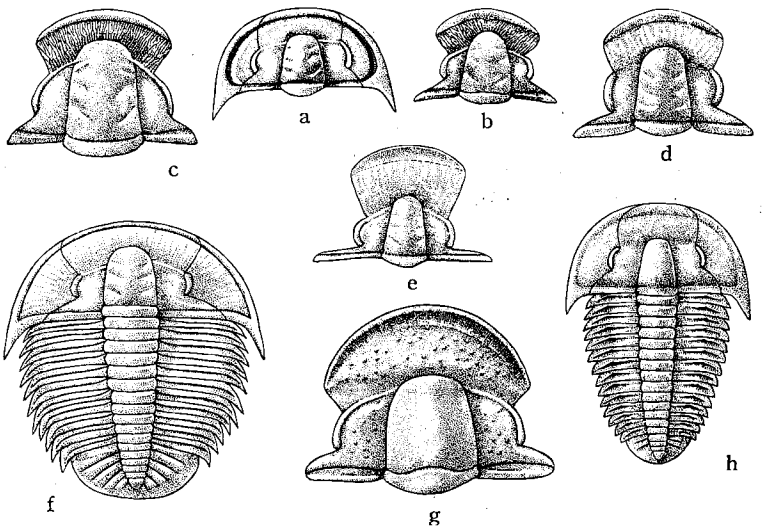


Figure 2. Ptychopariidae and allied genera.

a. *Proliostracus* (?) *brevicaudatus* SAITO and SAKAKURA
b. *Luia yaochiayuensis* CHANG
c. *Luia typica* CHANG
d. *Elrathia kikkawai* KOBAYASHI
e. *Amecephalus saitoi* KOBAYASHI
f. *Ptychoparia coreanica* KOBAYASHI
g. *Kounamkites rotundatus* TCHERNYSHEVA
h. *Elrathia chuwaensis* KOBAYASHI

Diagnosis:—Cephalon exclusive of genal spines semicircular; cranidium fairly long; glabella truncato-conical, more or less rounded in front, provided with two or three pairs of lateral furrows in different strength; eyes relatively small, located at mid-length of cranidium; fixed cheek narrow there; eye-ridge generally weak or obsolete; frontal limb convex, longer than frontal rim; axial lobe narrow in thorax and pygidium.

The thorax has 13 segments in the type-species, but 14 segments in *Elrathia permulta* (WALCOTT), 1918, (RASETTI, 1945).

Elrathia spenci RESSER as well as *R. rara* RESSER, 1939, having 17 segments in thorax is not diagnostic of this genus, because the anterior sutures are remarkably convergent and the cranidium and the fixed cheeks are broader in the species than in *Elrathia* s. str. The pygidium is usually flat, pauci-segmented and bordered by a smooth rim. A shallow sinuation is present on the pygidium of the type-species.

Remarks:—More than 15 species have been described from Eastern Asia under the generic name of *Elrathia*. These species and their present reference are listed below.

Original specific name	Present identification
conoidea ENDO, 1937, *Elrathia*	*Pseudoliostracina* (?)
convexa RESSER and ENDO, 1937, *Elrathia*	*Elrathia iddingsi*
granosa ENDO, 1937, *Elrathia* (plate) *granulosa* ENDO, 1937, *Elrathia* (text)	Solenopleuridae
hoboi RESSER and ENDO, 1937, *Elrathia*	*Elrathia*
iddingsi RESSER and ENDO, 1937, *Elrathia*	*Elrathia*
kikkawai KOBAYASHI, 1935, *Elrathia*, (Fig. 1d)	*Elrathia*
manchuriensis RESSER and ENDO, 1937, *Elrathia*	*Ptychoparia orientalis*
munda RESSER and ENDO, 1937, *Elrathia* (?)	*Wentsuia*
perconvexa RESSER and ENDO, 1937, *Elrathia* (?)	*Obrucheviaspis* (?)
rara ENDO, 1944, non RESSER, 1939, *Elrathia*	*Anomocarella* (?)
sobyosiensis ENDO, 1944, *Elrathia*	*Paramenocephalites*
spinifera KOBAYASHI, 1961, *Elrathia*	*Elrathia*
taihakuensis KOBAYASHI, 1935, *Elrathia*	*Elrathia*
taitzuensis ENDO, 1945, *Elrathia*	*Paramenocephalites* (?)
tenuilimbata ENDO, 1937, *Elrathia*	*Fuchouia* (?)
yentaiensis ENDO, 1944, *Elrathia*	*Taishania*

ENDO (1944) has synonymized *convexa* and *manchuriensis* with *iddingsi* and *Ptychoparia orientalis* respectively.

Though deformed, some complete dorsal shields are known of Mapanian *tenuilimbata*. Unfortunately its brief description makes me difficult to figure its specific concept, but it must be excluded from the Ptychopariidae by its forwardly expanding long glabella, large eyes apparently extending postero-laterally from the glabella and the very narrow pre-ocular fixed cheek, all of which being characteristic of the Dolichometopidae. The genal spine is present, the thorax composed of 11 segments and the pygidium of 5 or 6 segments; pleural and interpleural furrows present. It may be a *Fuchouia* which

is so far represented by dismembered cephala and pygidia. It is, however, not improbable to be a crudely distorted anomocarellid.

E. granulosa (i.e. *E. granosa*) is another interesting species procured from the Mapanian limestone. Its tumid oval glabella, broad convex cheeks and granulate test suggest the Solenopleuridae rather than the Ptychopariidae for its position. The pygidium is relatively large and long for these families. It is remarkably triangular in outline, and has 6 or 7 segments. The thorax appears to have about 11 segments and the axial ring is nearly as wide as the pleuron. Although the palpebral lobe and preglabellar aspect are obscure in the illustration, the frontal limb seems to be very narrow. Among the three Taitzuan species, *sobyosiensis*, *taitzuensis*, and *perconvexa*, the first and probably the second belong to *Paramenocephalites*. The third resembles *Obrucheviaspis* or the Solenopariinae having a large subcylindrical glabella and relatively narrow fixed cheeks. Taitzuan *conoidea* is also not a member of the Ptychopariidae. Judging from the outlines of the glabella and cranidium, it may be a *Pseudoliostracina*.

Taishania may be the best place for Changshanian (Paishan) *yentaiensis* to be located. Fengshanian (Yenchou) *munda* is represented by a small cranidium closely resembling *Wentsuia*.

Elrathia chuwaensis KOBAYASHI, 1935

PA4054-1014
PA4055-10-15
PA4058-11-9
PA4059-11-10

Plate X, Figures 14–15, Plate XI, Figures 9–10. Text-figure 2h.

1933. *Elrathia rinsonica* SAITO, *Jour. Geol. Soc. Tokyo, Vol. 40*, Text-fig, 3, (nom. nud.)
1935. *Elrathia chuwaensis* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 227, pl. 23, fig. 1.

As SAKAKURA (1936) has made SAITO's *Elrathia rinsonica* a synonym of *chuwaensis*, they are identical except for the thoracic segments which are countable 14 in the holotype of *chuwaensis*, 16 mm. long whereas SAITO's *rinsonica*, 18 mm. long has only 13 segments in thorax. Therefore forma *rinsonica* can be distinguished from typical *chuwaensis*, although it is a question whether the dimorphism is sexual or not. The same number is countable already on the dorsal shield of *rinsonica*, 8 mm. long.

Beside these there is a holaspid, 6.6 mm. long with 8 thoracic segments. Because its glabella is considerably larger than the precedings, in spite of the small difference in size from the last one (8 mm. in length), its specific identification cannot be warranted.

Elrathia kikkawai differs from this species in the longer cranidium, the rounded anterior margin of the glabella, and larger palpebral lobes.

Like forma *rinsonica*, *Yühsienszella szechuanensis* (SUN), in LU, 1939 has 13 segments in the holaspid-thorax. They are quite similar to each other, but the glabella is remarkably cylindrical and rounded in front in *szechuanensis*, but truncato-conical in *chuwaensis* inclusive of *rinsonica*.

Occurrence:—The two forms are both common in the Rinson shale of the

Chunghwa area, south of P'hyŏngyang, North Korea.

PA4058-11-1
PA4059-11-2,5
PA4060-11-3
PA4061-11-4
PA4062-11-6
PA4063-11-7,8

Elrathia hoboi RESSER and ENDO, 1937

Plate XI, Figures 1-8.

1937. *Elrathia hoboi* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 220, pl. 33, figs. 5-8.

Description:—Small ptychoparioid having semi-circular cephalon with genal spines of moderate length; cranidium relatively narrow; its breadth through eyes approximate to a half of cephalon; glabella truncato-conical, unfurrowed, but neck ring clearly demarcated by a furrow; eyes of medium size, their position being a little posterior to the mid-length of cranidium; fixed cheek somewhat narrower than free cheek; irregular striation imperceptible on frontal limb as well as ocular platform; marginal rim narrow; facial sutures widely devergent forward and backward from eyes. Thorax composed of 11 segments; axial ring about a fourth as wide as thorax; pleura mesially furrowed, gradually turning back in distal one-third and abruptly pointed at the end of posterior margin. Pygidium very wide, composed of about 4 or 5 segments; marginal rim narrow. Test smooth.

Observation:—This species was proposed by the authors with illustrations and a brief statement of its comparison with *Elrathia iddingsi* RESSER and ENDO which was again proposed in a similar way. Therefore the above is the first description of this species. In the full grown stage the glabella corresponds to two-thirds of the cranidium length or it is a little longer, and distinctly truncato-conical in outline, its breadth in front being about two-thirds that of the neck ring and nearly equal to that of the fixed cheek through eyes. The eye is shorter than one-third the length of the cheek through the eyes and located a little posteriorly. The eye-ridges are insignificant.

The collection contains carapaces of various growth stages. Three early holaspids are all different from the full grown form in the longer and less conical or even cylindrical glabella.

In fact the glabella inclusive of a neck ring is longer than four-fifths of the cranidium and the ring relatively long, if compared with that of the grown stage. The eye-ridge is usually seen distinctly.

Comparison:—At a glance this species resembles *Ptychoparia kochibei* WALCOTT, but that species has a smaller glabella, broader free cheek, narrower fixed cheek and more segments in thorax. More precisely, the glabella occupies three-fifths the length of the cranidium. Its breadth at the neck is nearly equal to the fixed cheek through eyes. There the free cheek is evidently narrower than the fixed cheek. Thorax has 14 segments.

This species agrees with *Elrathia kingi* in a little posterior position of eyes, contraction of the outline of the cranidium at eyes and the narrow axial lobe of the thorax. MEEK's is, however, different from this species in the

narrower fixed cheek, more distinct eye-ridge, longer frontal limb and the post-axial sinuation of the pygidium. An additional distinction is the thorax having two more segments than that of this species.

Occurrence:—Dark green Mapanian shale at Mapanshan, Chinchiachengtzu, at the neck of the Liaotung peninsula. ENDO's material was obtained from a similar Mapanian shale, north of Chinchou on the peninsula.

Elrathia cfr. *hoboi* RESSER and ENDO

Plate XI, Figure 12.

PA4064

A small ptychoparioid in the old collection of the University of Tokyo is diagnostic of *Elrathia hoboi* except for a little broader axial lobe and the thoracic pleura pointed at the end laterally, instead of postero-laterally in typical *hoboi*. In the anterior thoracic segments of this form the axial ring is as wide as the pleura. The boundary between the thorax and pygidium is somewhat obscure, but 11 rather than 12 segments appear movable.

In this specimen the impression of the hypostoma on the glabella shows the oblong central body and lunate posterior ridge separated by a deep groove.

Occurrence:—Dark gray shale probably of Mapan stage in Chinchiachengtzu, Fuhsien, Liaoning.

Elrathia spinifera KOBAYASHI, new species

PA4065-2-10
PA4066-2-11
PA4067-2-12
PA4068-2-13

Plate II, Figures 10–13.

Description:—Glabella of moderate size, outlined by deep dorsal furrows, a little tapering forward and subrounded in front; lateral furrows obsolete; occipital furrow profound; spine issuing from neck ring; fixed cheek a little narrower than glabella; palpebral lobe fairly large, connected with glabella by eye-ridge; frontal limb large, depressed and sculptured by irregular striae; frontal rim two-thirds as long as the limb, separated from the latter by a marginal furrow; anterior sutures divergent from eyes and recurving on border. Pygidium broad, semi-circular, with concave depressed border; axis narrow, composed of 3 rings and a terminal lobe; breadth of pleural lobe equal to pygidial length. Test smooth.

Comparison:—Because no other polymeric trilobite occurs at loc. 306, it is quite certain that the dismembered carapaces belong to an identical species. The broad pygidium and striated frontal limb show its being a ptychoparioid, and probably an ally to *Elrathia*, but the posterior sinuation is absent on this pygidium. The presence of a nuchal spine is also unusual for *Elrathia*.

This species bears some biocharacters common with *Idahoia*, although the glabella is much larger and the outline of the cranidium remarkably contracted at eyes in that genus. In the large size of the palpebral lobe and some other aspects it looks like *Iranella latifrons* (KING), but this Iranian species has three pairs of pitted lateral furrows. Compared to "*Idahoia*" *angulata*

KING from Iran the palpebral lobe is larger and the glabella more slender in this species.

Occurrence:—*Tonkinella* zone at loc. 306 and 311.

Genus *Elrathiella* POULSEN, 1927

PA4069-4-3 / PA4070-4-4

Elrathiella taira KOBAYASHI, new species

Plate IV, Figures 3-4.

Description:—Cranidium gently inflated; glabella two-thirds as long as cranidum, truncato-conical, outlined by deep dorsal furrows, a little elevated above cheeks; no lateral furrows; occipital furrow distinct; occipital ring a little thickened in the middle; palpebral lobe medium in size, connected with glabella; frontal limb and rim nearly equal in length where the latter is flat and smooth, while the former is a little inflated and striated by nerve-like lines.

Comparison:—This species agrees better with *Elrathiella* than *Elrathia* in the general outline of the cranidium, relative size of the glabella, fairly large palpebral lobe and distinct eye-ridge and well developed frontal border. Compared to *Elrathiella obscura* POULSEN, however, the facial sutures are somewhat more divergent forward. The glabella is narrower and three pairs of lateral furrows are present in that species. The nerve-like lines are very distinct on the cranidium in fig. 4.

Occurrence:—*Eochuangia* zone at locs. 292 and 301.

Genus *Luia* CHANG, 1959

1957. *Luia* CHANG, *Acta Pal. Sinica, Vol. 5. No. 1*, p. 31, (nom. nud.)
1959. *Luia* CHANG, *Ibid. Vol. 7, No. 3*, pp. 193, 215.

Type-species:—*Luia typica* CHANG, 1959, (Fig. 2c).

Remarks:—The second species is *Luia yanchiayuensis* CHANG. 1959, (Fig. 2b), having the well rounded anterior lobe of the glabella. *Ptychoparia tschanghsingensis* ENDO, 1937, is diagnostic of the genus except for the truncated glabellar outline and its effaced lateral furrows.

Compared to *Ptychoparia coreanica* the cranidium is longer, the glabella much larger and the palpebral lobes are larger in *Luia*. Thus, *Luia* approaches the Anomocarellinae, but still it has typical ptychoparian striae on the preglabellar field. It agrees with *Ptychoparia coreanica* in the diagonal facial sutures. *Luia* is intermediate in character between the Ptychopariinae and Anomocarellinae. However, it may not be a link between the two subfamilies, but a side-branch of the former.

Distribution:—Early Middle Cambrian; China.

Subfamily Alokistocarinae RESSER, 1939

As noted already in 1935, *Alokistocare*, *Amecephalus* and *Amecephalina*

constitute a distinct group of ptychoparioids usually having a wide concave preglabellar region. The third genus stand apart from the two others as indicated by its intramarginal facial suture, but *Alokistocare* and *Amecephalus* are more intimate. Subsequently in 1939 RESSER cited Alokistocaridae as the heading of the description of *Alokistocare*, *Alokistocarella*, *Kochina*, *Inglefieldia* and *Kochaspis* where the last is now generally known as a member of the Crepicephalidae. While RESSER synonymized *Amecephalus* with *Alokistocare*, RASETTI accepted their independence (1951) not only on the basis of distinctions in the cephalon but also by the difference of the thoracic pleura. HUPÉ (1953) separated them into two subfamilies of the Alokistocaridae where the Amephaphalinae are distinguished from the other chiefly by the flat or indistinct frontal border and the absence of the preglabellar median boss or depression. I think it too far going, but *Alokistocare* and *Amecephalus* are recognized here as two valid genera in the Alokistocarinae.

If the prolonged occipital spine can be overlooked, *Ptychoparia defossa* REED, 1910, is an *Amecephalus*.

Genus *Alokistocare* LORENZ, 1906

1906. *Alokistocare* LORENZ, *Zeitschr. deutsch. geol. Gesell. Bd. 58*, S. 62.
1916. *Alokistocare* WALCOTT, *Smithsonian Misc. Coll. Vol. 64, No. 3*, p. 182.
1935. *Alokistocare* RESSER, *Ibid. vol. 93, No. 5*, p. 4.
1945. *Alokistocare* LU, *Bull. Geol. Soc. China, Vol. 25*, p. 193.
1951. *Alokistocare* RASETTI, *Smithsonian Misc. Coll. Vol. 116, No. 5*, p. 203.
1953. *Alokistocare* HUPÉ, *Ann. de Pal. tom. 39*, p. 123.
1959. *Alokistocare* HOWELL, *Treatise of Invert. Pal. Pt. 0-1*, p. 238.
1960. *Alokistocare* BALASHOVA, IVSHIN and TCHERNYSCHEVA, *Principles of Pal. Vol. 8*, p. 107.

In Kueichou, South China this genus is represented by *Alokistocare magnum* LU and *A. meitanensis* LU, 1945, in addition to three imperfectly known forms, all from the early Middle Cambrian Kaotai formation.

Genus *Amecephalus* WALCOTT, 1924

1924. *Amecephalus* WALCOTT, *Smithsonian Misc. Coll. Vol. 75*, p. 53.
1925. *Amecephalus* WALCOTT, *Ibid. Vol. 75*, p. 65.

The well developed preglabellar area represents the most remarkable feature of *Ptychoparia tenuicaudata* ENDO, 1937, which suggests *Amecephalus* for its generic reference. In the narrow rim in comparison with the very long frontal limb and also in the palpebral lobes of moderate size this species is certainly close to *Amecephalus agnesensis* (WALCOTT), 1912.

Amecephalus saitoi KOBAYASHI, new species

Plate XI, Figure 11, Text-figure 2e.

PA4071

Description:—Ptychoparioid-cranidium relatively narrow at eyes for the

genus; glabella conical, truncated in front, provided with three pairs of shallow lateral furrows and a transverse occipital furrow; eye-ridge oblique; palpebral lobe fairly large and located posteriorly; fixed cheek at eye half as wide as neck ring, but wider than the ring on the posterior margin; postero-lateral limb of the cheek short and wide; preglabellar field about three-fourths as long as glabella and striated radially; no distinct marginal furrow but shallow concavity is seen along the frontal margin; facial suture divergent from eyes and apparently intramarginal on frontal border.

Comparison:—The cranidium is so strongly depressed secondarily that the original inflation can hardly be restored. Although there is no trace of the glabellar median boss, it is noted that the dorsal furrow distinct on the lateral sides of the glabella becomes obsolete in front.

As SAITO (1933) considered it an *Amecephalus*, its close resemblance with *Amecephalus piochensis* (WALCOTT) (1925) can hardly be overlooked. It is, however, easily distinguishable from that species by its narrower outline, longer glabella in comparison with the preglabellar field, oblique eye-ridges and larger eye. Compared to this the anterior margin is more transversal in that species and more arcuate in *Amesphalina mirabilis* POULSEN.

It is also similar to *Alokistocare subcoronatum* (HALL and WHITEFIELD) (WALCOTT, 1914), but the outline of this cranidium is more contracted at the eyes and more dilated at the postero-lateral limbs. The eyes are located more anteriorly, the eye-ridges not so oblique and the straight anterior part of the facial suture is shorter in that species. In many aspects *A. subcoronatum* is more allied to *A. magnum* LU, 1945, than this species. Compared to it the glabella is longer, eyes smaller and more anterior and the postero-lateral limb of the fixed cheek much larger in *A. magnum* as well as *A. meitanensis* LU.

Occurrence:—Rinson shale; north of Chunghwa area, North Korea (SAITO collection at loc. D_1).

Family Olenidae BURMEISTER, 1843

Putting aside *Olenus asiaticus* below described, this family is represented in Asia by *Parabolinella* and some other genera. One of them is *Protopeltura praecursor* WESTERGÅRD var. (Fig. 3 g) which occurs at Haraulah, North Siberia (LERMONTOVA, 1940). LOMOVITSKAJA (1955) reported the occurrence of *Parabolinella argentinensis* in the upper Tremadocian of the Amzas, Western Siberia. In Kazakstan *Acerocarina* (Fig. 3 f) is found in the Tremadocian and *Acerocare* (Fig. 3 j) and *Cyclognathina* are known from the later Upper Cambrian where the last is a new genus erected by LERMONTOVA (1951) with *Cyclognathina microps* LERM. (Fig. 3b). *Westergaardites* was instituted by TROEDSSON (1947) as a new genus of the Triarthrinae. Its type-species is *Westergaardites pelturaeformis* TROEDSSON from the Upper Cambrian of Eastern Tienshan (Fig. 3k) where it is accompanied by *Lotagnostus asiaticus*. HENNINGSMOEN (1957), however, suggested the high possibility of being a Tremadocian trilobite from its best agreement with *Plicatolina*. Finally, *Paraolenus* LERMONTOVA (1951) is

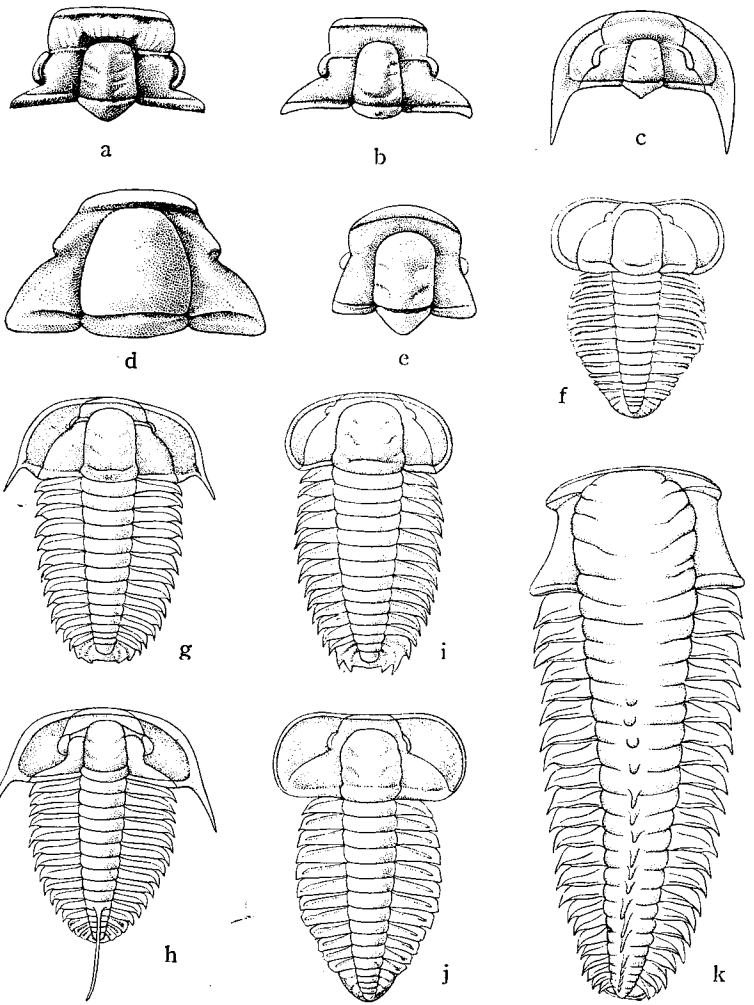


Figure 3. Olenidae.

a. *Prohedinia solida* POLETAYEVA
b. *Pianaspis kodairai* SAITO and SAKAKURA
c. *Chittidilla plana* KING
d. *Cyclognathina microps* LERMONTOVA
e. *Prohedinella erbiensis* SIVOV
f. *Acerocarina micropyge* (LINNARSSON)
g. *Protopeltura praecursor* WESTERGÅRD
h. *Leptoplastus stenosus* WESTERGÅRD
i. *Peltura scaraboeoides* (WAHLENBERG)
j. *Acerocare ecorne* ANGELIN
k. *Westergaardites pelturaeformis* TROEDSSON

founded on *P. papilionaceus* LERM. from the Upper Cambrian of Kazakstan. As it is not diagnostic of the Olenidae, its referrence to the family is questioned by BALASHOVA et al. (1959).

Subfamily Oleninae BURMEISTER, 1843

Genus *Olenus* DALMAN, 1827

As pointed out already (1936, 38), *Olenus* (?) *indicus* WAAGEN, 1891, and *Olenus haimantensis* REED, 1910, from the Himalaya are respectively a solenopleurid and a ptychoparioid and *Olenus* sp. by LORENZ, 1906, from Shantung is represented by a pygidium of either *Maladioides* or *Changshania*. Therefore *Olenus asiaticus* is the sole representation of true *Olenus* in Asia. Its original description is cited below.

PA/991-9-16a
PA/992-9-16b

Olenus asiaticus KOBAYASHI, 1944

Plate IX, Figures 16a-b.

1944. *Olenus asiaticus* KOBAYASHI, *Proc. Imp. Acad. Tokyo, Vol. 20*, p. 229, text-figs. 12-b.
1957. *Olenus asiaticus* HENNINGSMOEN, *Skr. Ut. av. Det. Norske Vetensk. Akad. i Oslo, I, Mat.-Naturv. Kl. 1957, No. 1*, p. 102.

Description:—Cranidium subtrapezoidal in general outline; glabella moderately convex, very short for *Olenus*, subquadrate, gently tapering forward, slightly elevated above cheeks and well defined by a dorsal furrow which is deep, especially on the lateral sides; the first pair of lateral furrows faint, short and convex forward; the second pair a little longer, fairly distinct and slightly oblique; third pair of furrows deep, quite oblique to the axis, and apparently confluent with each other; occipital furrow also deep and more or less bent forward on the lateral sides; occipital ring narrow but thickened and somewhat elevated in the middle part; eyes relatively large, occupying the middle one-third of the length of the cranidium; ocular ridge nearly straight and extends from points a little behind the lateral extremities of the anterior margin of the glabella, to points a little anterior to the lateral side; fixed cheek broad, gradually elevated toward the eye; preglabellar field large; fine lines on it aligned subparallel in front of the glabella but more or less radiating on the lateral sides; frontal rim narrow, nearly straight and upraised; marginal furrow deep; facial sutures anterior to the eyes nearly parallel to each other and diagonal on their posterior side.

The other parts of the carapace are unknown. The following dimensions are measured on the holotype cranidium.

Length of the cranidium	5.2 mm.
Breadth of the cranidium measured through the eyes	6.3 mm.
Breadth of the cranidium measured along the occipital margin	9.6 mm.
Length of the glabella	3.4 mm.
Breadth of the glabella	3.1 mm.

Comparison:—Compared to *Parabolina* and *Parabolinella* the glabella is small and the eyes are quite large in this species. Its anterior facial sutures are not divergent forward as in *Parabolinella* as well as in *Proaulacopleura*. Insofar as the cranidium is concerned, it is typical of *Olenus*, and especially similar to that of *O. gibbosus* (WAHLENBERG) (WESTERGÅRD, 1922, HENNINGSMOEN, 1957) which is the type of the genus, but the glabella is shorter and the eyes are located more posteriorly and somewhat larger. On these accounts this species resembles *Proaulacopleura buttsi* KOBAYASHI, (1936), but in the latter species the cranidium is narrow, lateral glabellar furrows are obscure, eye-ridges transversal and the anterior branches of the facial sutures are divergent forwardly.

Occurrence:—*Glyptagnostus* zone at locs. 241 and Ita 1.

? Family Oleninae

Genus *Hancrania* KOBAYASHI, new genus

Diagnosis;—Olenid-like trilobites but having divergent anterior facial sutures and large eyes at mid-length of cranidium; further details included in the description of the type-species.

Type-species:—*Hancrania brevilimbata* KOBAYASHI, new species.

Remarks:—This genus can be easily distinguished from *Olenus* by the course of the facial sutures, from *Parabolinella* by the size and position of the eyes and from *Proaulacopleura*, *Aphelaspis* and *Elvinia* by the proportional size of the glabella to the cranidium. Among the American genera *Olenaspella* WILSON, 1956, may be the nearest to this genus, but they are distinct from each other as clarified below by the comparison between their type-species.

Distribution:—Early Upper Cambrian; Eastern Asia and western North America.

Hancrania brevilimbata KOBAYASHI, new gen. and sp.

Plate IX, Figures 2-6.

Description:—Glabella large, gently convex, subquadrate, slightly tapering forward, and bordered by deep dorsal furrow; its frontal margin more or less rounded; two pairs of lateral furrows oblique; occipital furrow transversal except both extremities where it is bent forward; neck ring a little thickened in middle where a tubercle exists; fixed cheek narrow; palpebral lobe occupying middle third the length of cranidium; eye-ridge short and slightly sloping backward; frontal limb and rim both convex and separated by a furrow; frontal limb about twice as long as frontal rim; facial suture running a little outward from eye and intramarginal on frontal limb; surface smooth.

Observation:—The holotype and two paratypes measure as follows:

Specimen	Holotype	Paratype 1	Paratype 2
Length of cranidium	4.7 mm.	3.3 mm.	3.1 mm.

Breadth of cranidium through eyes	5.1 mm.	4.1 mm.	4.0 mm.
Breadth of cranidium along articulating margin	7.6 mm.	25.5 mm.	5.4 mm.
Length of glabella	3.8 mm.	3.8 mm.	2.9 mm.
Breadth of neck ring	2.8 mm.	2.1 mm.	2.0 mm.

A hypostoma associated with the holotype cranidium (Fig. 2) has an elongately ovate central body, a marginal rim and antero-lateral wings. In a thoracic segment found on the same slab the axial ring is a little narrower than the pleura and the pleural end pointed backward.

A meraspid cephalon 0.4 mm. long (Fig. 5) is subtrapezoidal and has a narrow subcylindrical axis which is divided into five rings by transversal furrows. The largest of them is the frontal lobe which is more or less expanded forward.

Another meraspid cephalon, 0.7 mm. long (Fig. 6) is broader and eyes are well developed, but the glabella maintains the same aspect as the preceding.

Comparison:—This species is very similar to *Parabolinella* (?) *evansi* KOBAYASHI, 1936, which is the type species of *Olenaspella*. The cranidium is, however, broader, the glabella more convex, its outline tapering forward more rapidly, glabellar furrows more pronounced, eye-ridges more oblique and the frontal limb larger in *evansi* than in this species. The second species is *Olenaspella occidentalis* (WILSON), 1951, which has a more conical and narrower glabella. It is a remarkable distinction that nerve-like lines are well developed in the frontal limb of *Olenaspella* as well as *Eugonocare* WHITEHOUSE, 1939, to which WILSON compared *Olenaspella*, but the lines are obsolete and the frontal limb appears smooth in *Hancrania*.

Occurrence:—*Hancrania* zone; boulder at loc. 242.

Subfamiliy Leptoplastinae ANGELIN, 1854

Genus *Ctenopyge* LINNARSSON, 1880

Ctenopyge (?) sp. indt.

PA4072

Plate VIII, Figure 23.

Though very imperfect, the find of *Ctenopyge*-like free cheek in Eastern Asia is of great interest. The lateral margin of the cheek is more strongly round on the anterior than on the other side. The spine which springs out between the two parts is curved strongly at first, but later the curvature is reduced. Unfortunately the cheek is strongly depressed and its inner outline obsure. It is found together with *Komaspis* (*Parairvingella*) *megalops*. Seeing its resemblance with the cheek of *Carolinites*, it is possible for the cheek to belong to *megalops*. However, it is more probable that the other cheek which is also found associated with the cranidia of *megalops* belongs *megalops*, judging from the coincidence of the carapace-margins along the facial suture.

Occurrence:—Black shale at loc. 196.

Subfamily Papyriaspidinae WHITEHOUSE, 1939

This subfamily was proposed by the author to include four Asio-Australian genera as follows:

Pianaspis SAITO and SAKAKURA, 1936, from early Middle Cambrian of North Korea.

Papyriaspis WHITEHOUSE, 1939, from the Middle Cambrian of North-Western Australia.

Rhodonaspis WHITEHOUSE, 1939, from the Upper Cambrian of North-Western Australia.

Hedinaspis TROEDSSON, 1952, (i.e. *Hedinia* by TROEDSSON, 1937), from the Upper Cambrian of Tienshan.

They are particularly well characterized by the flatness of the test and by the relatively narrow axis. WHITEHOUSE suggested the possible derivation of the Olenidae from the Ptychopariidae through this subfamily. While HENNINGSMOEN (1955) excluded it from the Olenidae, HUPÉ (1953) and BALASHOVA, SUVOROVA and TCHERNYSHEVA (1960) accepted the Papyriaspinae as a subfamily of the Olenidae. The Olenidae are combined with the Papyriaspididae and Hypermecaspididae in the Olenacea in Treatise (1959).

More informations are expectable in future in Asia on the phylogenetical relation between the Atlantic and Pacific trilobites. Although it is premature to solve the question, it is noteworthy that three new genera were erected there with the thought of their being ancestral to *Hedinapsis*.

Prohedinia LERMONTOVA and TCHERNYSHEVA, 1950, is one of them which is distributed in the Middle Cambrian of North and Western Siberia. It is founded on *P. attenuata* LERMONTOVA which reveals greater similarities to *Olenus* than *Hedinaspis* in the cephalon, but intermediate between the two genera in the relative breadth of the axial lobe and the number of thoracic segments. *Prohedinia solida* POLETAYEVA (1955) from the late Middle Cambrian of the Altai (Fig. 3a) is represented by the cranidium which is very much like that of *H. regalis*, but the glabella is shorter and more quadrangular, and located more posteriorly. The preglabellar field is larger and has a median boss, instead of a triangular depression in *Hedinaspis*. Like *H. regalis* 3 or 4 pairs of lateral furrows are present on the glabella and the posterior furrow is bifurcated inward into a transversal anterior branch and a diagonal posterior one in *Prohedinia solida*.

Prohedinella SIVOV, 1955, is founded on *P. erbiensis* SIVOV from the middle Upper Cambrian of the Kuznetsk Alatau, west Siberia (Fig. 3e) which is fairly distinct from *Hedinaspis* in the narrowness of the cranidium and the broadness of the glabella in relative to the fixed cheeks. With regard to small eyes, however, *Hedinaspis* agrees better with *Prohedinella* than *Prohedinia*. The glabella of *Prohedinella* is provided with only 2 pairs of distinct lateral furrows, posterior ones of which are long, oblique and bent back near the axis. As

noted by HENNINGSMOEN (1959), it agrees with *Welleraspis* in some aspects. The glabella is however, much larger in *Welleraspis* in proportion to the cranidium. The size of the palpebral lobe, strength of the eye-ridge and the convexity of the frontal rim are also different between them.

It is interesting to find that *Prohedinella* is more similar to *Protohedinia* than *Prohedinia*. *Protohedinia* was erected by ENDO, 1944, and its type-species is *P. distincta* ENDO from the Middle Cambrian Taitzu formation of Liaoning. In the general outline of the cranidium and glabella it resembles *P. solida* closely, but its glabella is comparatively small and possesses 4 pairs of lateral furrows. The preoccipital furrow is bifurcated inward by a mammillary process. The aspect of the glabella is typical of *Hedinaspis*, but the cranidia of this genus as well as *Prohedinella* are much narrower and their glabellae broader for the Papyriasidinae.

Finally, *Chittidilla plana* KING, 1941, from the *Neobolus* beds of the Salt range (Fig. 3c) is closely allied to *Pianaspis kodairai* (Fig. 3b), both having the broad cranidium, narrow glabella, straight transverse eye-ridges and subparallel anterior facial sutures. As noted by KING, the obscure demarcation between the frontal rim and limb is a distinctive biocharacter from ptychopariids and also from the typical papyriaspids. The lateral border is, however, well defined inside on the free cheeks. If it be referable to this subfamily, *Chittidilla* is the oldest member.

Genus *Hedinaspis* TROEDSSON, 1952

"Hedinaspis" granulatum KOBAYASHI, new species

Plate IX, Figure 7.

PA3996

Description:—Cranidium very broad, twice as broad as long, culminating towards the axial carination; glabella quadrate, three-fourths as long as cranidium, expanding backward, axially keeled, somewhat incised at the anterior median point, provided with three or four pairs of short lateral furrows which are pitted at a short distance from dorsal furrows; anterior furrows insignificant; posterior furrows bifurcate; occipital furrow straight except for lateral termini; neck ring thickened mesially where a tubercle exists; fixed cheek a little wider than glabella; eyes probably small, located a little anterior to the mid-length of cranidium connected with glabella by very prominent ridges which run a little oblique to the axis; postero-lateral limb of the cheek large, well dilate laterally; preglabellar field of moderate size gently slant forward and abruptly bent up toward a narrow frontal rim which is thickened toward the middle; small lenticular area vaguely outlined between frontal limb and rim; facial sutures somewhat divergent in front of eyes; their posterior branches run more laterally than posteriorly for a long distance and then abruptly turn backward; test smooth but the cheeks behind eye-ridges are granulate.

Comparison:—Among Middle Cambrian trilobites *Andrarina costata* (AN-

GELIN) is the nearest that I think of. The small cranidium of that species from Kjupadalen, Västergötland (WESTERGÅRD, 1948, pl. 4, figs. 1a-b) is particularly similar to this species, but this is evidently more developed in the larger glabella and other features. In the Olenidae it ressembles *Olenus* and *Parabolinella*, but it is quite different in one or the other character. Namely, the anterior sutures are convergent in *Olenus* and the cranidium is narrower, the glabella and eyes are much larger in *Parabolinella*, although the anterior sutures are divergent in *Parabolinella*.

This species is somewhat allied to *Papyriaspis lanceola* WHITEHOUSE, 1939, but the cranidium is not flat and the anterior sutures by no means convergent in this species. That species bears fine radial wrinkles in the preglabellar field as seen in many ptychopariids. WHITEHOUSE is of opinion that *Papyriaspis* is most similar to *Hedinia* TROEDSSON, 1939, i.e. *Hedinaspis* TROEDSSON, 1951. Between the two genera this agrees better with *Hedinaspis*, especially in the glabellar configuration, the course of sutures and some other biocharacters, but the glabella is more rounded, anterior margin straight or even concave and the occipital furrow is shorter than the ring in that genus. The granulation on the postero-lateral limb of the fixed cheek is the speciality not seen in any of these genera. A new genus must be erected for this form when a better material is obtained.

Occurrence:—*Hancrania* zone; boulder at loc. 242.

Genus *Rhodonaspis* WHITEHOUSE, 1939

Rhodonaspis (?) *similis* KOBAYASHI, new species

Plate IX, Figure 1. PA4073

Cranidium small, very broad; glabella short, narrow, tapering gradually backward, somewhat keeled and marked by three pairs of short lateral furrows; fixed cheek broad, but narrower than glabella; eyes fairly large (?), connected with glabella by a ridge which is slightly declined back; preglabellar field large, well expanded; frontal rim narrow, arcuate and convex; facial sutures a little divergent forward from eyes.

The broad cranidium, narrow glabella, three lateral furrows, broad fixed cheek, large eye, large frontal limb, wire-like frontal rim and forwardly divergent anterior facial sutures of this species are all diagnostic of *Rhodonaspis*. It bears resemblances with *Rhodonaspis lingula* WHITEHOUSE, but the glabella is strictly parallel-sided and narrower than the fixed cheek and eye-ridge expanding laterally at right angle to the axis in *lingula*. In the slightly oblique eye-ridge it resembles *R. prospecta* WHITEHOUSE.

Occurrence;—*Hancrania* zone; boulder at loc. 242.

Family Emmrichellidae KOBAYASHI, 1935

Subfamily Emmrichellinae KOBAYASHI, 1935

The subfamily is represented by *Emmrichella* WALCOTT, 1911, for which the narrow cylindrical unfurrowed glabella, broad fixed cheeks, large palpebral lobes located far posteriorly and the straight depressed frontal border are quite distinctive. *Ptychoparia theano* WALCOTT, 1905, from the Middle Cambrian Changhia limestone of Shantung is the type-species of the genus. Another species is *Ptychoparia* (*Emmrichella*) *chengshanensis* SUN, 1924, from the Manto (?) shale formation of Hopei.

Subfamily Liostracininae RAYMOND, 1937

As *Liostracina* and *Emmrichella* were once combined in a subfamily, they are similar in the quadrate cranidium, subcylindrical narrow glabella, effaced lateral furrows, posterior eyes and depressed frontal border. The preglabellar axial furrow is, however, a characteristic of the subfamily very rare among polymeric trilobites. The eyes are small in *Liostracina* as well as *Liostracinoides*. They are located more anteriorly in the latter than the former. A pair of tiny lobes are found in *Liostracina* on the sides of the glabella base.

Genus *Liostracina* MONKE, 1903

1903. *Liostracina* MONKE, *Jahrb. königl. preuss. geol. Landesanst. u. Bergakad. Bd. 23, Heft. 1*, S. 114.
1913. *Liostracina* WALCOTT,*Cambrian Faunas of China*, p. 143.
1935. *Liostracina* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 251.
1937. *Liostracina* RAYMOND, *Bull. Geol. Soc. Am. Vol. 48*, p. 1092.
1953. *Liostracina* HUPÉ, *Ann. de Pal. Tom. 39*, p. 151.
1959. *Liostracina* HOWELL, *Treatise on Invert. Pal. 0-1*, p. 248.

Type-species:—*Liostracina krausei* MONKE, 1903.

Remarks:—Compared to the type-species, the cranidium is more convex and the glabella longer in *Liostracina* (?) *pauper* RESSER and ENDO, 1939, and the glabella is said still longer and accordingly the frontal limb shorter in *L.* (?) *paupeforme* ENDO, 1944.

Distribution:—Taitzuan and Kushanian; Eastern Asia. Cfr. *Liostracina* sp. by LOCHMAN and HU (1961) is represented by a few tiny cranidia, 1 mm. long, from the *Cedaria* zone of Wyoming. No adult specimen of *Liostracina* has as yet been discovered in North America.

Subfamily Bowmaniinae KOBAYASHI, 1937

Here the Utianae KOBAYASHI, 1937, is combined with the Bowmaniinae in a subfamily where the latter has page priority. Their common features are the broad cranidium, small oblong or sometimes oval glabella, distinct eye-ridges often crossing the fixed cheeks obliquely, subparallel or divergent facial sutures in front of medium sized eyes, and so on. The following genera are tentatively included in this subfamily. The type-species is cited behind each

genus.

Amechilus ROSS, 1951. (*Amechilus paraola* ROSS)
Amginouyia TCHERNYSHEVA, 1956. (*Amginouyia elegans* TCHERNYSHEVA)
Bowmania WALCOTT, 1925. (*Arethusina americana* WALCOTT)
Conococheaguea RASETTI, 1959. (*Conococheaguea ovata* RASETTI)
Gaphuraspis IVSHIN, 1947. (*Gaphuraspis kalievi* IVSHIN)
Inouyia WALCOTT, 1911. (*Agraulos ? capax* WALCOTT)
Leptopilus RAYMOND, 1924. (*Leptopilus declivis* RAYMOND)
Lichnocephala ROSS, 1951. (*Lichinocephala bicornuta* ROSS)
Maiaspis TCHERNYSHEVA, 1956. (*Maiaspis mirabilis* TCHERNYSHEVA)
Metabowmania KOBAYASHI, 1955. (*Metabowmania latilimbata* KOBAYASHI)
Paragraulos LU, 1941. (*Paragraulos kummingensis* LU)
Phoreotropis RAYMOND, 1924. (*Phoreotropis puteatus* RAYMOND)
Phylacterus RAYMOND, 1924. (*Phylacterus saylesi* RAYMOND)
Probowmania KOBAYASHI, 1935. (*Ptychoparia ligea* WALCOTT)
Stenocombus RAYMOND, 1937. (*Stenocombus princeps* RAYMOND)
Utia WALCOTT, 1924. (*Utia curio* WALCOTT)
Yongwolia KOBAYASHI, nov. (*Yongwolia ovata* KOBAYASHI)

Here *Paragraulos* is transferred from the Agraulidae to Emmrichellidae, and a new genus, *Yongwolia*, is erected. *Probowmania ligea* (Fig. 4b) from the Misakian of Shantung is the oldest of the subfamily which still bears much of ptychopariid aspects, as it has been referred to *Ptychoparia*. It is so similar to *Gaphuraspis* (Fig. 4e) from the early Middle Cambrian of Kazakstan, but the glabellar furrows and eye-ridges are obsolete in that genus.

The frontal limb and rim are united in *Amginouyia* (Fig. 4a) whereas the frontal boss is well developed on *Inouyia* (Fig. 4d). In the bipartation of the preglabellar area *Maiaspis* (Fig. 4c) from the Middle Cambrian of Siberia agrees with *Phylacterus* from the Upper Cambrian of Vermont.

Utia and *Phoreotropis* are allied to each other, but the eye-ridges are distinct in the former and obsolete in the latter. The outline of the cranidium is remarkably contracted at the small eyes and the anterior margin strongly

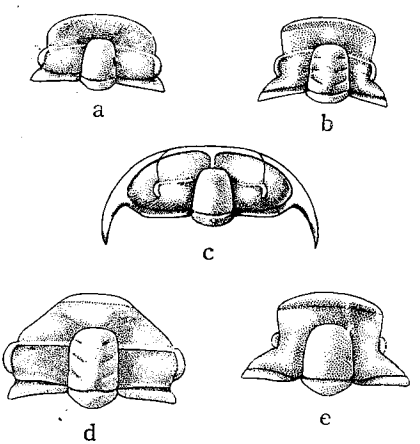


Figure 4. Bowmaniinae.
a. *Amginouyia elegans* TCHERYSHEVA
b. *Probowmania ligea* (WALCOTT)
c. *Maiaspis mirabilis* TCHERYSHEVA
d. *Inouyia capax* (WALCOTT)
c-d. *Gaphuraspis kalievi* IVSHIN

arcuate in *Bowmania*. *Conococheaguea* is possibly a highly specialized genus of this subfamily along the trend of *Bowmania*.

The glabella is small and ovoid in *Metabowmania*. The anterior sutures are parallel in this genus, but arcuate in *Amechilus* and *Lichnocephala* which the last has also an ovoid glabella. These three genera resemble *Leptopilus* in one or the other aspect.

Finally, *Stenocombus* is quite unlike *Blountia* in its cylindrical glabella. Its frontal furrow is, however, unusually deep for the Bowmaniae.

Distribution:—Late Lower Cambrian to Lower Ordovician; Northern hemisphere.

Genus *Paragraulos* LU, 1941

1941. *Paragraulos* LU, *Bull. Geol. Soc. China, Vol. 21, No. 1*, p. 84.
1942. *Inouyops* RESSER, *Smiths. Misc. Coll. Vol. 101, No. 15*, p. 24.
1957. *Paragraulos* LU, *Index Fossils of China. Inervert. Vol. 3*, p. 270.
1960. *Paragraulos* KOBAYASHI, *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 12, Pt. 2*, p. 385.

Type-species:—*Paragraulos kummingensis* LU, 1941.
Distribution:—Lower and Middle Cambrian of Eastern Asia.

PA4074

Paragraulos parvicaulis KOBAYASHI, new species

Plate I, Figure 2.

This species is not quite typical of *Paragraulos*, because the frontal limb is very large, nearly flat and so strongly expanded beyond the lateral limits of the palpebral lobes. Nevertheless, it bears some generic characters common with *P. titiana* or *P. kummingensis*. Although the glabella is very slender, it is truncato-conical in outline and provided with three pairs of oblique lateral furrows. The occipital furrow is straight and transversal. The occipital ring is thickened mesially but carries no median spine. The palpebral lobes are medium in size and connected with the glabella by distinct eye-ridges which run across the fixed cheeks obliquely. The cheeks through the eyes are nearly as wide as the glabella. The frontal rim is wire-like and takes a well arcuate course. The facial sutures are widely divergent forward and shortly intramarginal on the marginal border.

Occurrence:—*Tonkinella* zone at Nei 2.

Genus *Yongwolia* KOBAYASHI, new genus

Diagnosis:—Glabella short, ovate, and subcarinate axially; occipital ring thickened mesially; palpebral lobe small or medium in size, and located posteriorly; eye-ridge oblique; fixed cheek narrow at eye; preglabellar area large, expanded laterally; frontal limb moderately convex; frontal rim narrow, wire-like and strongly arcuate.

Type-species:—*Yongwolia ovatus* KOBAYASHI, new species.

Remarks:—This genus resembles *Paragraulos*, but they can easily be disinguished by the outline which is truncated in front in *Paragraulos*. Furthermore, the frontal limb is not so large but strongly convex and the neck ring is pointed back in the typical forms of *Paragraulos*.

In the small conical glabella and large preglabellar field this agrees better with *Metabowmania*, but in *Metabowmania* the fixed cheeks are broader, the anterior facial sutures subparallel to each other and the frontal margin is nearly straight. Like in this genus the margin is strongly arcuate and the anterior sutures are divergent in *Bowmania*, but the glabella is not conical and the palpebral lobes are smaller in that genus.

In my opinion *Ptychoparia* (*Conocephalites*) *hesterna* REED, 1910, from Spiti belongs to this genus, unless it represents a new genus by itself.

Distribution:—Middle Cambrian of Eastern and (?) Southern Asia.

Yongwolia ovata KOBAYASHI, new species

PA4075

Plate I, Figure 1.

Description:—Glabella surrounded by deep dorsal furrows, ovoid, two-fifths as long as cranidium, twice as broad as fixed cheek at eye, fairly convex, distinctly carinate along axis, and provided with very weak lateral furrows in two or three pairs; occipital furrow deep; occipital ring narrows laterally; palpebral lobes opposed at the middle third of glabella; eye-ridge strongly oblique; postero-lateral limb of fixed cheek a little shorter than glabella; preglabellar area large, moderately convex; frontal rim wire-like and strongly arcuate; anterior sutures diagonal.

Occurrence:—*Tonkinella* zone at Ita 10.

Yongwolia kagasi KOBAYASHI, new species

PA4076

Plate X, Figure 10.

Description:—Glabella no more than a half of cranidium in length, trigonally ovate, strongly convex, elevated, subangulated on the axis; lateral furrows obsolete; occipital furrow shallow; occipital ring moderately thick; dorsal furrow deep; eye-ridge low and diagonal; palpebral lobe medium in size, located far posteriorly; frontal limb large, slightly inflated and gradually inclined forward; frontal rim narrow and somewhat thickened intramarginal on frontal border; test smooth.

Occurrence:—*Tonkinella* zone at Ita 10.

Yongwolia (?) *hesterna* (REED)

1910. *Ptychoparia* (*Conocephalites*) *hesterna* REED, *Pal. Indica, Ser. 15, Vol. 7, Mem. No. 1*, p. 32, pl. 4, fig. 6.

This species agrees with the generic diagnosis in the ovoid glabella, large

frontal limb, arcuate anterior margin and so forth. However, it differs from the preceding two species in some aspects that this cranidium and fixed cheeks are broader, the palpebral lobe is larger, the eye-ridge nearly horizontal and almost obsolete, the marginal border flat and the test distinctly granulate. The unusual configuration of this glabella is the important distinction from these Korean species which might require its isolation in the generic rank.

Occurrence:—Horizon No. 6, Parahio valley, Spiti.

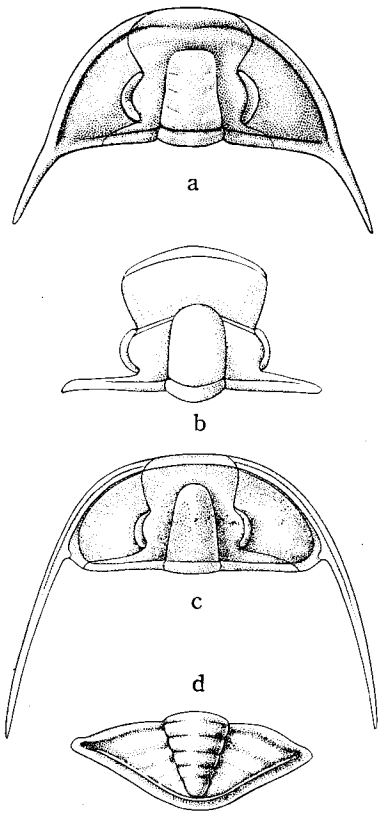


Figure 5. Changshaninae.
a. *Parachangshania hsiaoshihensis* CHIEN
b. *Wentsuia granulosa* SUN
c-d. *Changshania conica* SUN

Subfamily Changshaniinae
KOBAYASHI, 1935
(i.e. Family Changshaniidae
HUPÉ, 1953)

Genus *Changshania* SUN, 1924

1924. *Changshania* SUN, *Pal. Sinica, Ser. B, Vol. 1, Fasc. 4*, p. 44.
1955. *Changshania* HUPÉ, *Ann. de Pal. Tom. 41*, p. 190.
1957. *Changshania* LU, *Index Fossils of China, Invert. Vol. 3*, p. 283.
1959. *Changshania* HOWELL and MOORE, *Treatise on Invert. Pal. Pt. O-1*, p. 247.
1960. *Changshania* BALASHOVA, SUVOROVA and TCHERNYSHEVA, *Principles of Pal. Vol. 8*, p. 102.

Type-species:—*Changshania conica* SUN, 1924, (Figs. 5c-d).

Remarks:—Beside *conica*, the following 7 species have been described as *Changshania* members, their present generic reference being cited behind the original specific name.

equilis SUN, 1935, *Changshania* .... *Changshania*
konoi ENDO, 1937, *Changshania* .... *Changshania* (?)
liaotungensis KOBAYASHI, 1931, *Changshania* (?) ..*Changshania*
modesta ENDO, 1937, *Changshania* ..... *Changshania*
parallela ENDO, 1937, *Changshania* .....*Changshania* (?)
orbiculata ENDO, 1937, *Changshania* .....*Lioparia*
truncata SUN, 1924, *Changshania* (?) .....*Shirakiella* (?)

Ptychoparia (?) *bromus* WALCOTT, 1905, from the Kushanian of Shantung

is probably a *Changshania*, although the broad postero-lateral limb of the fixed cheek is unpreserved. *C. modesta* is another Kushanian member. ENDO reported the occurrence of *C. conica* at the Fengshanian Yenchou formation at Paichiashan, Fuchou-hsien Liaoning, but it was represented only by a pygidium.

Occurrence:—Kushanian to (?) Fengshanian, but common in Changshanian and Daizanian; Shantung, Hopei, Liaoning and North Korea.

Genus *Parachangshania* CHIEN, 1958

1958. *Parachangshania* CHIEN, *Acta Pal. Sinica, Vol. 6, No. 4*, pp. 455, 467.

Type-species:—*Parachangshania hsiaoshihensis* CHIEN, 1958, (Fig. 5a).

Remarks:—The closest ally to this genus is *Changshania* from which it is distinguished chiefly by the broader glabella, three pairs of lateral furrows which are weak, but still discernible, narrower fixed cheeks, narrower posterior limb, more divergent anterior facial sutures and by the pygidium which is not pointed laterally as in *Changshania*. Probably caused by the broader doublure, there are a pair of the so-called preocular lobes on the cranidium which dilate laterally from the front of the glabella.

Detailed observations are described by CHIEN on the ontogeny of the monotypic species. According to him the proparian suture of the late metaprotaspid changes into the opisthoparian one of the middle meraspid and later stages through the gonatoparian suture of the early meraspid stage.

Distribution:—Changshanian (*chunagia* zone); Liaoning.

Genus *Wentsuia* SUN, 1935

1935. *Wentsuia* SUN, *Pal. Sinica, Ser. B, Vol. 7, Fasc. 2*, p. 38.
1959. *Wentsuia* HOWELL, *Treatise on Invert. Pal. O-1*, p. 288.

Type-species:—*Wentsuia granulosa* SUN, (Fig. 5b).

Diagnosis:—Changshaniinae with short subcylindrical glabella, relatively broad fixed cheek, fairly large palpebral lobe, distinct eye-ridge, large concave frontal limb, narrow raised frontal rim, laterally extended postero-lateral limb of fixed cheek and finely granulate test; glabellar furrows effaced.

Remarks:—*Anomocarella baucis* WALCOTT agrees with the above diagnosis except for the narrow posterior limb and punctate texture.

Distribution:—Changshanian (*Chuangia* zone); Shantung.

Family Agraulidae RAYMOND, 1913

Subfamily Agraulinae RAYMOND, 1913

Genus *Megagraulos* KOBAYASHI, 1935

1935. *Megagraulos* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol, 4, Pt. 2*, p. 199.
1953. *Megagraulos* HUPÉ, *Ann. de Pal. Tom. 39*, p. 150.

Type-species:—*Megagraulos coreanicus* KOBAYASHI, 1935.
Remarks:—The genus is represented by the following species:—
Agraulos obscura WALCOTT, 1906
Agraulos uta WALCOTT, 1906
Agraulos vivi WALCOTT, 1906
Agraulos similans REED, 1910
(?) *Agraulos sorge* WALCOTT, 1911
Chondroparia reedi KOBAYASHI, 1935
Megagraulos (?) *semicircularis* KOBAYASHI, 1935
Megagraulos medius KOBAYASHI, new species
Megagraulos breviscapus KOBAYASHI, new species
Distribution:—Middle Cambrian; Eastern and Southern Asia.

Megagraulos medius KOBAYASHI, new species

PA4077-2-2
PA4078-2-3

Plate II, Figures 2-3.

This is a fairly large form showing close resemblances with *Megagraulos coreanicus*, but the glabella is less convex and shorter, occupying just about two-thirds the cranidial length. Compared to that species, palpebral lobes are somewhat larger and eye-ridges weaker. The preglabellar field is bipartate more or less distinctly; rim slightly longer than the frontal limb.

Occurrence:—*Eochuangia* zone at locs. 274 and 292.

PA4079

Megagraulos breviscapus KOBAYASHI, new species

Plate II, Figure 1.

This is an aberrant form of this genus well characterized by the unusually short glabella, very narrow fixed cheek, small palpebral lobes, vestiges of eye-ridges and well developed preglabellar area which corresponds to two-thirds the glabella in length, and is scarcely divided into frontal limb and rim; anterior sutures parallel to the axis in front of eyes and then describe a quarter of a circle. The dorsal furrow is distinct, but the occipital furrow rudimentary and lateral furrows are effaced.

Occurrence:—*Eochuangia* zone at loc. 274.

PA4080

Megagraulos cfr. *coreanicus* KOBAYASHI, 1935

Plate X, Figure 11.

1935. cfr. *Megagraulos coreanicus* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo. Sec. 2, Vol. 4, Pt. 2*, p. 207, pl. 18, figs. 5-10.

The cranidium at hand agrees with *M. coreanicus* in the relatively large, truncato-conical and moderately convex glabella, obsolete lateral furrows, weak occipital furrow, neck ring of uniform breadth, more or less depressed fixed cheeks and the preglabellar aspect, but its specific identification is hesitated

because the palpebral lobe is poorly preserved, eye-ridge effaced and the anterior facial sutures appear convergent forward.

Occurrence:—*Megagraulos* zone at Dai 1.

Genus *Metagraulos* KOBAYASHI, 1935

1935. *Metagraulos* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 199.
1937. *Yabeia* REESER and ENDO, *Manchurian Sci, Mus. Bull. 1*, p. 297.
1953. *Metagraulos* HUPÉ, *Ann. de Pal. Tom. 39*, p. 114.
1953. *Yabeia* HUPÉ, *Ibid.* p. 135.
1957. *Metagraulos* LU, *Index Fossils of China, Invert. Vol. 3*, p. 270.
1959. *Yabeia* LOCHMAN-BALK, *Treatise on Invert. Pal. Pt. O-1*, p. 309.

Type-species:—*Agraulos nitida* WALCOTT, 1905.

Specific list:—

Anomocare nanum DAMES, 1883
Agraulos abrota WALCOTT, 1905
Agraulos dirce WALCOTT, 1905
Agraulos dolon WALCOTT, 1905
(?) *Agraulos dryas* WALCOTT, 1905 (=*M. nanum*)
Yabeia laevigata RESSER and ENDO, 1937, (Cranidium only)
Metagraulos (?) *intermedius* KOBAYASHI, 1942
Metagraulos tienshihfuensis ENDO, 1944
Metagraulos sampoensis KOBAYASHI, 1961

Distribution:—Middle Cambrian; Eastern Asia.

Metagraulos sp. nov.

Plate V, Figure 14.

PA4081

This cranidium is medium in size and not so convex as often seen in *Metagraulos*; glabella truncato-conical and abrupty expanded near the occipital furrow; oblique posterior furrow tolerably pronounced on the glabella; two others very weak; neck ring produced back into a median spine; occipital furrow deep; palpebral lobes fairly large; fixed cheeks moderate in breadth.

Occurrence:—*Eochuangia* zone at loc. 296.

Metagraulos (?) sp. nov.

Plate V, Figure 1.

PA4082

The cylindrical glabella separated from cheeks by profound furrows is a distinctive feature of this species not seen in other species of this genus. The palpebral lobe is moderate in size; eye-ridge obscure; occipital furrow deep; occiptal ring thickened mesially, preglabellar area undivided and simply convex; frontal margin nearly straight; anterior sutures subparallel to each other.

Occurrence:—*Eochuangia* zone at Ita 2.

Genus *Kuljumbina* LAZARENKO, 1960

1960. *Kuljumbina* LAZARENKO, *Short Pap. for Pal. & Biostratigr. 20*, p. 17.

Type-species:—*Kuljumbina grandis* LAZARENKO, 1960.

Remarks:—*Plethopeltis stenorachis* KOBAYASHI, 1943, is represented by a small cranidium which best agrees with *K. grandis*, especially with LAZARENKO's small one in fig. 1, pl. 2, in the outlines of the cranidium and glabella, their relative size, effacement of lateral furrows, distinct dorsal and occipital furrows, triangular neck ring, small eyes, their fairly anterior position and especially in the presence of the distinct preocular groove which is not seen in *Plethopeltis*. In the grown form of *K. grandis*, in fig. 3, pl. 2, the cranidium is broader and the dorsal and preocular furrows are much stronger.

Distribution:—Upper Cambrian of Siberia.

Subfamily Plethopeltinae RAYMOND, 1925

Genus *Plethopeltella* KOBAYASHI, 1943

1943. *Plethopeltella* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 6, Pt. 12*, p. 320.
1959. *Plethopeltella* LOCHMAN-BALK, in *Treatise on Invert. Pal. 0-1*, p. 315.

Type-species:-*Plethopeltis resseri* KOBAYASHI, 1933.

Remarks:—*Plethopeltis shantungensis* LU, 1957, from the Fengshanian of Shantung has a considerably larger glabella and the much narrower frontal border and fixed cheeks in comparison with *Plethopeltis*. Compared to Wanwanian *Plethopeltella orientalis* (KOBAYASHI) and *Plethopeltella resseri* (KOBAYASHI) its glabella is more or less small and the cranidium less convex in the axial profile, but *Plethopeltis shantungensis* is certainly better placed in *Plethopeltella* than *Plethopeltis*.

Genus *Plethometopus* ULRICH, 1931

PA23/0

Plethometopus longispinus KOBAYASHI, 1958

Plate X, Figure 19.

1958. *Plethometopus longispinus* KOBAYASHI, *Trans. Proc. Pal. Soc. Japan, N. S. No. 30*, p. 214, text-fig. 3.

Occurrence:—*Dictyites* zones at Tanyo. 7.

Subfamily Kingstoniinae KOBAYASHI, 1933

Genus *Kingstonia* WALCOTT, 1924

1924. *Kingstonia* WALCOTT, *Smithsonian Misc. Coll. Vol. 75, No. 2*, p. 58.
1925. *Kingstonia* WALCOTT, *Ibid. Vol. 75, No. 3*, p. 103.
1933. *Kingstonia* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 3, Pt. 7*, p.

277.

1933. *Kingstonia* KOBAYASHI, *Japan. Jour. Geol. Geogr. Vol. 9, Nos. 1-2*, p. 143.
1935. *Kingstonia* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 201.
1944. *Kingstonia* SHIMER and SHROCK, *North American Index Fossils*, p. 627.
1952. *Kingstonia* SHAW, *Jour. of Pal. Vol. 26, No. 3*, p. 471.
1953. *Kingstonia* HUPÉ. *Ann. de Pal. Tom. 39*, p. 115.
1958. *Kingstonia* KOBAYASHI, *Trans. Proc. Pal. Soc. Japan, N.S. No. 30*, p. 213.
1959. *Kingstonia* LOCHMAN, *Treatise on Invert. Pal. O-1*, p. 285.
1960. *Kingstonia* SUVOROVA, *Principles of Pal. Vol. 8*, p. 85.

Type-species:-*Kingstonia apion* WALCOTT, 1924.

Remarks:—RESSER (1936) has synonymized *Ucebia* WALCOTT, 1924, with *Kingstonia*, the opinion being upheld by LOCHMAN (1959) and some others. SHAW (1959) suppressed *Ithycephalus* RESSER, 1938, noting that its type-species, *I. typicalis* RESSER, is based on an exfoliated cranidium of *Kingstonia*. LOCHMAN, however, accepts the genus as a member of the Pagodiidae.

A large number of species were described from various localities of North America by LOCHMAN, RASETTI, RESSER, SHAW and others. According to LOCHMAN the genus *Kingstonia* is limited to the Dresbachian in North America. In Eastern Asia the following 7 species of *Kingstonia* have been described.

Kingstonia convexa KOBAYASHI, 1933, from the Wanwanian
Kingstonia humilis KOBAYASHI, 1933, from the Wanwanian
Kingstonia kuantungensis ENDO, 1937, from the Changshanian (Paishan)
Kingstonia paichiaensis KOBAYASHI, 1933, from the Changshanian
Kingstonia parallela KOBAYASHI, 1958, from the Fengshanian
Kingstonia perconvexa ENDO, 1937, from the Changshanian (Paishan)
Kingstonia semicircularis KOBAYASHI, 1933, from the Wanwanian

K. perconvexa is represented by a narrow cranidium resembling *Symphysurina; K. kuantungensis* appears an effaced *Pagodia*. It is difficult for me to say the proper generic position of these two species, but the other species fit in *Kingstonia* better than any other genus. It means that *Kingstonia* ranges from Changshanian to Wanwanian.

It is quite obvious that none of these five species has the cranidium as narrow as *Stenopilus convexus* which occurs in the Wanwanian. Because the effacement is far advanced, it is hard to point out the difference of the three Wanwanian species from *Leiobienvillia laevigata* RASETTI, 1954, but it can hardly be overlooked that the palpebral lobes which are quite rudimentary are located more posteriorly in them than in *L. laevigata*. No pygidium is known of either *Bienvillia* or *Leiobienvillia*, but it is known that the pygidium of *K. semicircularis* is diagnostic of *Kingstonia*. However, a further study is needed for these species with additional material, because their horizon is too high, in comparison with the generic range in North America.

Distribution:—Dresbachian in North America; Upper Cambrian and Basal Ordovician in Eastern Asia.

Kingstonia parallela KOBAYASHI, 1958

Plate X, Figures 18a-b.

1958. *Kingstonia parallela* KOBAYASHI, *Trans. Proc. Pal. Soc. Japan, N.S. No. 30*, p. 213, Text-fig. 2a-b.

Occurrence:—*Dictyites* zone at Tanyo 9.

Family Ptychaspididae RAYMOND, 1924

Subfamily Saukiinae ULRICH and RESSER, 1933

Genus *Hamashania* KOBAYASHI, 1942

Hamashania (?) sp.

Plate X, Figure 17.

1958. *Hamashania* (?) sp. KOBAYASHI, *Trans. Proc. Pal. Soc. Japan, N.S. No. 30*, p. 215, text-fig. 4.

Occurrence:—*Dictyites* zone at Tanyo 7.

Family Solenopleuridae ANGELIN, 1854

Subfamily Solenopleurinae ANGELIN, 1854

Litaspis SUVOROVA, 1960, which is founded on *Litaspis pudens* SUVOROVA, from the Lower Cambrian of the Lena district, North Siberia is a new genus referred by the author to the Solenopleurellinae HUPÉ, 1953. From *Solenopleurella* POULSEN, 1927, *Litaspis* can be distinguished by the nearly parallel-sided and slightly shorter glabella, somewhat larger palpebral lobes, presence of a narrow frontal limb and divergent anterior facial sutures.

Subfamily Solenopariinae HUPÈ, 1953

Genus *Solenoparia* KOBAYASHI, 1935

Solenoparia subtoxea KOBAYASHI, new species

Plate V, Figure 5.

The small cranidium closely related to *Ptychoparia* (*Liostracus*) *toxeus* WALCOTT which is the type-species of *Solenoparia*. The glabella is, however, comparatively large and less conical than that of *toxeus;* eye-ridge, though very faint, still discernible by cross light.

Occurrence:—*Eochuangia* zone at loc. 274.

Genus *Grandioculus* COSSMANN, 1908

1906. *Megalophthalmus* LORENZ, *Zeitschr. deutsch. geol. Gesell. Bd. 58*, p. 76.
1908. *Grandioculus* COSSMANN, *Rev. crit. pal. Paris, Vol. 12*, p. 68.
1937. *Megalophthalmus* KOBAYASHI, *Jour. Geol. Soc. Japan, Vol. 44*, p. 433.

1959. *Gradioculus* HOWELL, in *Treatise on Invert. Pal. Pt. 0-1*, p. 290.

Type-species:—*Liostracus megalurus* DAMES, 1883, (Figs. 6c-d).

Diagnosis:—Glabella very large, convex, conical, well rounded in front and wide at base; lateral furrows weak; eyes medium in size and opposed at mid-length of cranidium; ocular ridge flat or convex; test smooth or provided with fine granules.

Remarks:—COSSMANN's proposal of *Grandioculus* was made by the reason that LORENZ's generic name is preoccupied by *Megalophthalmus* GRAY, 1832. *Anomocare megalurus* by WALCOTT, 1913, which has the truncato-conical glabella must be excluded from this genus. Accordingly, HOWELL's diagnosis of *Grandioculus* which was founded on WALCOTT's form is incorrect.

Ptychoparia (*Liostracus*) *thraso* WALCOTT and possibly *P.* (*L.*) *subrugosa* WALCOTT belong to this genus, because they agree in most essentials, although the frontal rim is depressed and flat in the type species and convex in them. In the type-species as well as in *thraso* the pygidium is slightly sinuate at rear and has double furrows on pleurae, which run into the remarkably depressed marginal border.

Distribution:—Middle Cambrian; Liaoning and Shantung.

Genus *Peishania* RESSER and ENDO, 1937

1937. *Peishania* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 254.
1953. *Peishania* HUPÉ, *Ann. de Pal. Tom. 39*, p. 119.
1959. *Peishania* HOWELL, in *Treatise on Invert. Pal. Pt. 0-1*, p. 292.

Type-species:—*Peishania convexa* Resser and Endo, 1937, (Figs. 6e-f).

Remarks:—Compared to the preceding, the lateral furrows are obsolete, fixed cheeks broader, palpebral lobes smaller and eye-ridge obscure in *Peishania*. The frontal rim is a little convex in the type-species, but flat in *Peishania affinis* RESSER and ENDO, 1937, and also *Peishania lubrica* CHANG, 1959. Except *P. granulosa* RESSER and ENDO, 1937, the test is smooth. Insofar as the cranidium is concerned, they look congeneric with *Grandioculus megalurus*, but the detached pygidia referred to the two genera are fairly different. *Peishania* is probably no more than a subgenus of *Grandioculus*. In some way it is intermediate between *Paramenocephalites* and *Grandioculus*. *Peishania parallela* ENDO, 1944, may be better placed in *Paramenocephalites*.

Distribution:—Middle Cambrian (Taitzuan); Liaoning and Shantung.

Subfamily Menocephalitinae KOBAYASHI, 1960

Genus *Ninaspis* IVSHIN, 1956

1956. *Ninaspis* IVSHIN, *Upper Cambrian Trilobites from Kazakstan, Vol. 1*, p. 54.
1960. *Ninaspis* IVSHIN, MAKSIMOVA, SUVOROVA and TCHERNYSHEVA, *Principles of Pal.* p. 121.

Type-species:—*Ninaspis tchernyshevae* IVSHIN, 1956, (Fig. 6b.)

Diagnosis:—Solenopleurioid provided with large, ovoid, convex, unfurrowed

glabella, narrow neck ring, narrow fixed cheeks with palpebral lobes of moderate size at mid-length of glabella, weak oblique eye-ridges and narrow distinctly up-turned frontal rim; frontal limb absent; anterior facial sutures subparallel to each other.

Remarks:—The genus was first compared with *Genevievella*, but it looks to me to bear greater affinity to *Onchonotus* and other small solenopleurioids.

Distribution:—Upper Cambrian; Kazakstan.

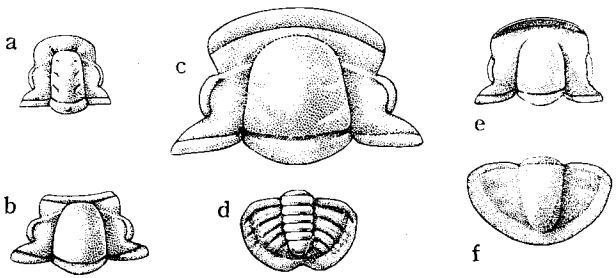


Figure 6. Solenopleuridae.
a. *Acrocephalina trisulcata* KOBAYASHI
b. *Ninaspis tchernyshevae* IVSHIN
c-d. *Grandioculus megalurus* (DAMES)
e. *Peishania convexa* RESSER and ENDO

Subfamily Solenopleuropsinae THORAL, 1949

(i.e. Subfamily Saoinae HUPÉ, 1953)

It is certainly a remarkable fact that this Acadian subfamily is represented in Asia by *Pardailhania* MANSUY, 1922, which was recently described by DEAN and KRUMMENACHER (1961), from the Amanos mountains, southern Turkey.

Family Dokimocephalidae KOBAYASHI, 1935

Subfamily Dokimocephalinae KOBAYASHI, 1935

Genus *Iddingsia* WALCOTT, 1924

"Iddingsia" orientalis KOBAYASHI, 1958

Plate X, Figure 16.

PA2311

1958. *Iddingsia orientalis* KOBAYASHI, *Trans. Proc. Pal. Soc. Japan, N.S. No. 30*, p. 214.

Occurrence:—*Dictyites* zone at Tanyo 7.

Subfamily Acrocephalitinae HUPÉ, 1953

Genus *Acrocephalina* TROEDSSON, 1937

The pygidium referred to *Acrocephalina borealis* LAZARENKO, 1960, is certainly congeneric with the one found together with the cranidia of *Lecanopleura glabella* KOBAYASHI, 1943. The combination of these dismembered carapaces, however, cannot be warranted until their complete shields will be found.

Acrocephalina trisulcata KOBAYASHI, 1944

Plate IX, Figure 17, Text-figure 6a.

PA/993

1944. *Acrocephalina trisulcata* KOBAYASHI. *Proc. Imp. Acad. Vol. 20*, p. 230, text-fig. 5.

A small strongly convex cranidium, 2.5 mm. long; glabella long, truncato-conical, distinctly elevated above cheeks and subcarinated along the axis; dorsal furrow deep in whole length; anterior lateral furrow short and transversal; middle one longer; posterior one longest and quite oblique; last two lateral and occipital furrows all deep; occipital ring proportionally narrow but thickened toward the middle where a median tubercle exists; eyes relatively small and opposed to the second glabellar lobe. The breadth of a fixed cheek measured through the eyes corresponds to about a half of the breadth of the glabella, strongly inclined laterally; preglabellar area convex and steeply slant forward; a pair of diagonal furrows extending from the lateral ends of the frontal furrow of the glabella; preglabellar area between them more or less swelling up to form a median boss. Anterior facial sutures subparallel; posterior ones diagonal. Surface ornamented by fine tubercles.

Comparison:—Because the median preglabellar area is imperfectly preserved, whether a frontal spine is present or not is indeterminable. But at any rate it has no occipital spine as seen in *Acrocephalites stenometopus* ANGELIN, (WESTERGARD, 1922). From *A. vigilans* WALCOTT and RESSER (1924) it can be easily distinguished by the much narrower outline of this cranidium. In the absence of the frontal border and the presence of the eye-ridge it is certainly closer to *Acrocephalina* than *Acrocephalites*. Except in the absence of the occipital spine there is no essential difference from *Acrocephalina armata* TROEDSSON (1937) which is the monotypic species of the genus.

Occurrence:—*Glyptagnostus* zone; a boulder at loc. Ita 1.

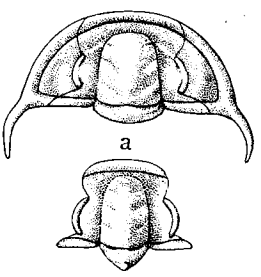


Figure 7. Crepicephalidae.
a. *Mesocrepicephalus damia* (WALCOTT)
b. *Crepicephalina convexus* (WALCOTT)

Family Crepicephalidae KOBAYASHI, 1935

In Eastern Asia this family is represented by the three genera as follows:—
Kochaspis RESSER, 1935, i.e. *Palaeocrepicephalus* KOBAYASHI, 1935 (*Crepicephalus liliana* WALCOTT). Tangshihan (Hsuchuanian of Shantung).
Mesocrepicephalus KOBAYASHI, 1935 (*Crepicephalus damia* WALCOTT). Tangshihan and Taitzuan.

(Fig. 7a).

Crepicephalina RESSER and ENDO in KOBAYASHI, 1935 (*Crepicephalus convexus* WALCOTT). Taitzuan. (Fig. 7b).

Among 15 species of crepicephaloids from Eastern Asia it is certain that 6 species are crepicephalids.

Crepicephalus damia WALCOTT, 1905 ..... *Mesocrepicephalus*
Crepicephalus magnus WALCOTT, 1905 ..... Gen. et sp. indt.
Crepicephalus convexus WALCOTT, 1911 ..... *Crepicephalina*
Crepicephalus airaghii KOBAYASHI, 1935 ..... *Mesocrepicephalus*
Crepicephalus subquadratus KOBAYASHI, 1935 ..... *Mesocrepicephalus*
Crepicephalina pergranosa RESSER and ENDO, 1937 ..... *Mesocrepicephalus*?
Crepicephalina mukdensis RESSER and ENDO, 1937 ..... *Mesocrepicephalus*
Crepicephalina quadrata RESSER and ENDO, 1937 ..... *Mesocrepicephalus*?
Crepicephalina concavolimbata ENDO, 1937 ..... *Chuangia*?
Crepicephalina intermedia ENDO, 1937 ..... *Kaolishania*?
Crepicephalina laevis ENDO, 1937 ..... new genus?
Crepicephalina bispinosa ENDO, 1937 ..... new genus
Crepicephalina orientalis ENDO, 1937 ..... *Lioparia*
Crepicephalina chinchiaensis ENDO, 1937 ..... new genus?
Kochaspis hsuchuangensis LU, 1957 ..... *Kochaspis*

Crepicephalus magnus is too fragmentary to grasp its specific concept; *pergranosa* and *quadrata* are represented by the cranidia of *Mesocrepicephalus* rather than *Crepicephalina*, although the generic reference cannot be warranted without their pygidia. *C. laevis* is quite distinct from the Crepicephalidae. The quadrate pygidium with two pairs of short spines combined with the cranidium having the short conical glabella shows that *C. bispinosa* represents an undescribed genus.

As pointed out already (1960), *orientalis* is typical of *Lioparia*. *Concavolimbata* and *intermedia* are two other Paishanian members which do not belong to the Crepicephalidae. *Chinchiaensis* from the Daizanian resembles "*Elkia*" *orientalis* on one side and *Changshanocephalus reedi* on the other, but it bears its own characteristics. For *Temnura* I have already commented in my previous papers (1951, 60).

Genus *Mesocrepicephalus* KOBAYASHI. 1935

1935. *Mesocrepicephalus* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 277.
1953. *Mesocrepicephalus* HUPÉ. *Ann. de Pal. Tom. 39*, p. 158.
1960. *Mesocrepicehhalus* BALASHOVA, SUVOROVA and TCHERNYSHEVA, *Principles of Pal.* p. 98.

This genus can easily be distinguished from *Kochaspis* by its narrower fixed cheeks and from *Crepicephalina* by its conical glabella separated from the rim by the frontal limb. Its difference from *Crepicephalina* is more marked in the pygidium of which axis is very stout and cylindrical in *Crepicephalina*,

but slender and tapering back in *Mesocrepicephalus*. The aspects of the pleural lobes and spines are also different between the two genera.

PA4084-1-18
PA4085-2-14
PA4025-2-10
PA4086-10-6
PA4087-10-7

Mesocrepicephalus subquadratus (KOBAYASHI)

Plate I, Figure 18: Plate II, Figures 14 and (?) 15; Plate X, Figures 6-7.

1935. *Crepicephalus subquadratus* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 281, pl. 16, fig. 6.

Only the pygidium has been known of this species which is closely allied to the succeeding species, but the marginal border is better defined and the spines are not so prolonged as in that species. Interpleural furrows are often well shown beside the pleural ones, but the furrows are generally obsolete and only the latters remain in that species.

In association with the pygidia of this species there are several cranidia which are similar to the cranidium of the succeeding species, but the palpebral lobes are larger, the fixed cheeks broader and their postero-lateral limbs smaller. The glabella of this species is conical, rounded in front, strongly convex, highly elevated above the cheeks, and provided with three pairs of slender glabellar furrows; occipital furrow profound; palpebral lobe relatively large, as strong as the eye-ridge; frontal limb slightly narrower than the fixed cheek; frontal border crescentic and depressed.

Occurrence:—*Tonkinella* zone at locs. 109 and 304; *Olendoides* zone of Neietsu.

Mesocrepicephalus airaghii (KOBAYASHI)

PA4088-1-19
PA4089-10-9

Plate I, Figure 19; Plate X, Figure 9.

1935. *Crepicephalus airaghii* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 280, pl. 16, figs. 1-2.

A cranidium from loc. 302 agrees with the type cranidium in the truncato-conical glabella, strong, oblique, somewhat pitted glabellar furrows, deep occipital and dorsal furrows, palpebral lobes of medium size located close to the glabella and large postero-lateral limb of the fixed cheek extended laterally.

The pygidium from loc. 109 coincides with the type pygidium of this species in all details except for the spiniferous third pleural rim which is stronger than in the type specimen. In this respect this pygidium agrees with the pygidium of *damia*, but the pygidium and especially the pleural lobes are narrower and there are only 3 pleural ribs, instead of 5 ribs in *airaghii*.

Occurrence:—*Tonkinella* zone at loc. 109 and Ita 10; *Eochuangia* zone at loc. 302; *Olenoides* zone of Neietsu.

Family Conokephalinidae WALCOTT, 1913

This family includes opisthoparian trilobites having large semicircular palpebral lobes close to the glabella. The pygidium is small and sometimes spiniferous. The thoracic pleurae truncated or falcate. The glabella is generally a little tapering forward and in front it is subtruncated or more or less

rounded. The thorax is composed of 12 segments in *Lakella*, and 14 segments in *Lobocephalina* and probably in *Yosimuraspis*.

Compared with the *Anomocare* and *Anomocarella* groups, the fixed cheeks are narrow and the palpebral lobes, usually terminate very close to the glabellar base in this family, while they are usually set more apart from the glabellae in these groups. The palpebral lobe is usually not so large in the Anomocarellinae. The distinction of this family from the Anomocarinae becomes more obvious, if comparison is made between the associated pygidia. The pygidium is generally large and well rounded in the Anomocarinae and the marginal border developed in the typical genera of the subfamily.

Beside *Conokephalina* the following genera tentatively referred to this family:

Wuhuia KOBAYASHI, 1933. (*Solenopleura belus* WALCOTT)
Lobocephalina RUZICKA, 1940. (*Lobocephalus carnatus* RUZICKA)
(?) *Meisterella* IVSHIN, 1943. (*Meisterella meisteri* IVSHIN)
(?) *Shoriella* SIVOV, 1955. (*Schoriella shorica* SIVOV)
(?) *Catuniella* JEGOROVA, 1956. (*Catuniella digna* JEGOROVA)
Yosimuraspis KOBAYASHI, 1960. (*Yosimuraspis vulgaris* KOBAYASHI)
Lakella KOBAYASHI, nov. (*Conocoryphe invitus* SALTER)
Westergaardella KOBAYASHI, nov. (*Conokephalina olenorum* WESTERGÅRD)

Previously I have placed *Yosimuraspis* in the Monkaspidae, but it is more properly located in this family.

Distribution:—Middle Cambrian to Tremadocian; Eurasia.

PA4090-9-18

Genus *Conokephalina* BRÖGGER, 1886

Type-species:—*Conocephalites ornatus* BRÖGGER, 1878, cranidium from loc. 1c of Krekling. (Pl. IX, Fig. 18).

Diagnosis:—Glabella large, subquadrate, slightly tapering forward, clearly outlined, none of which is, however, connected with each other on the axis, anterior furrow horizontal and weak; middle one a little slant; posterior furrow strong and oblique; palpebral lobe long, fairly large and set close to the glabella; frontal limb short; frontal border convex and thicker than the limb; facial sutures almost semicircular in front of the eyes and running along the frontal margin; those behind the eyes transversal, but diagonal where they cross the posterior border; test smooth.

Remarks:—The above description is made principally on the basis of the cranidium from loc. 1c of Krekling. The pygidium from the same bed is somewhat lenticular in outline. Its axis is conical and consists of four or five rings. The first pleural furrow is much stronger than the others. The marginal border narrows toward the hind of the axis and appears serrated.

In a depressed cranidium from loc. 1c d which may be specifically distinct from *ornatus* the fixed cheek is broader and the palpebral lobe united with the glabella by a palpebral ridge. A depressed cranidium of *ornatus* var.? from loc. 1c differs considerably from the these cranidia in its broader fixed cheek,

wider frontal limb, narrower frontal rim and the course of anterior facial suture. These distinctions may segregate this form *Conokephalina*.

LAKE (1931) has reviewed a long history of discussion attached to the American species referred to it by BRÖGGER or WALCOTT, are now removed from this genus to some other genera as follows:

megalops BILLINGS, 1865, *Dikelocephalus* ..... *Richardsonella* (type)
misa HALL, 1863, *Dikelocephalus* ..... *Prosaukia* (type)
osceola HALL, 1863, *Dikelocephalus* ..... *Osceola* (type)
spiniger HALL, 1863, *Dikelocephalus* ..... *Calvinella*, (type)
whitechallenis WALCOTT, 1912, *Conokephalina* ..... *Conaspis*

Likewise, there were more than 10 Asiatic species, none of which, however, belongs to the genus in the strict sense.

belus WALCOTT, 1905, *Solenopleura* ..... *Wuhuia* (type)
dryope WALCOTT, 1905, *Ptychoparia* ..... *Wuhuia*
gerardi SUN, 1924, *Conokephalina* ..... *Anomocarella* (*Manchuriella*)
kaipingensis SUN, 1924, *Conokephalina* ..... *Anomocarella* (?)
latifrons MANSUY, 1916, *Conokephalina* ..... *Anomocarella* (*Manchuriella*)
maia WALCOTT, *Ptychoparia* (?) ..... *Saimachia* (?)
oblongata MANSUY, 1916, *Conokephalina* ..... *Anomocarella* (*Manchuriella*)
sinensis MANSUY, 1916, *Conokephalina* ..... *Eymekops*
termieri MANSUY, 1916, *Conokephalina* ..... *Hundwarella*
tienfongensis MANSUY, 1916, *Conokephalina* ..... *Hundwarella*
vesta WALCOTT, 1906, *Ptychoparia* ..... *Anomocarella* (*Manchuriella*)
waltheri SUN, 1935, *Conokephalina* ..... ?

In *Conokephalina waltheri* the cranidium is subtrapezoidal, glabella more or less conical and strongly convex, palpebral lobe medium in size, fixed cheek of moderate breadth, its postero-lateral limb subtriangular and fairly large and the anterior facial sutures are parallel and then run inward on the frontal border. The combination of these biocharacters excludes the species from the Conokephalinidae. It represents an undescribed genus probably of the Lioparliinae.

Finally, there are several European species which appear to constitute some local specific groups as follows;

1. *Ptychoparia* (*Conokephalites*) *marginata* POMPECKJ, 1896, from the Middle Cambrian of Bohemia is the second species of *Lobocephalina*.
2. The following three British species which were referred to *Conokephalina* by LAKE are more allied *Yosimuraspis* than *Conokephalina* but they can be distinguished as a separate group for which *Lakella* is proposed.
   Conocephalus invitus SALTER, 1859
   Conocoryphe abdita SALTER, 1866
   Conokephalina lata LAKE, 1931
3. *Westergaardella* is erected for the following two Swedish species.
   Conokephalina suecicus WALLERIUS, 1895
   Conokephalina olenorum WESTERGARD, 1922
   Distribution:—Middle Cambrian; Scandinavia.

Genus *Westergaardella* KOBAYASHI, new genus

Diagnosis:—Cephalon with ovoid or subcylindrical glabella, large semicircular palpebral lobes detached from the glabella by a narrow interspace, frontal limb of moderate length, long genal spines and marginal facial sutures on the frontal border; thoracic segment falcate at the pleural end.

Type-species:—*Conokephalina olenorum* WESTERGÅRD, 1922, (Figs. 8a-d).

Remarks:—As noted by WESTERGÅRD, the type-species from the *Parabolinella spinulosa* and *Orusia lenticularis* zone is so similar to *Conocephalites suecicus* WALLERIUS, 1895, from the *Lejopyge laevigatus* zone that they are thought congeneric. Both of them are quite distinct from *Conokephalina ornata* in their broader fixed cheeks. Lateral glabellar furrows are present in *suecicus*, but they are in two pairs. The furrows are completely effaced in *olenorum*. The associated pygidium is long and well round in *suecicus* but short and lenticular in *olenorum*. Their margins are entire.

Distribution:—Latest Middle Cambrian and early Upper Cambrian of Sweden.

"*Westergaardella*" *coreanica* KOBAYASHI, new species

Plate IX, Figure 8.

Description:—Glabella large, three-fourths as long as cranidium, conical, rounded in front and well defined by dorsal furrows; lateral furrows obsolete; occipital furrow distinct; a long median tubercle or short spine present on neck ring; fixed cheek narrow; palpebral lobe large and located close to glabella; eye-ridge short but prominent; frontal limb twice as long as frontal rim; a row of minute tubercles seen on exfoliated part of marginal furrow; facial sutures broadly divergent from eyes and intramarginal on frontal border; posterior branches gently inclined backward; test apparently smooth. The holotype cranidium is 7.3 mm. long.

Comparison:—This cranidium bears many biocharacters which suggest the relationship to *Westergaardella* except for the conical outline of the glabella, the possession of eye-ridge and the prominence of the median tubercle or spine on the occipital ring. On these accounts it resembles *Idahoia* and *Iranella*. The palpebral lobe is larger than that of *Idahoia* and the fixed cheek narrower than that of *Iranella*. The small preglabellar field of *Saratogia* is a clear distinction of the genus from this form. In these three genera the glabella is distinctly truncated in front, while it is well rounded in this form.

Not only the outline of the glabella, but some other aspects of the cranidium also show the similarity of this form with *Asaphiscus*, but the palpebral lobe is much smaller in that genus. This form is similar to *Blainia* and *Blainiopsis*, but the frontal limb is very narrow in them. The prominence of the eye-ridge and the occipital spine or node is an additional distinction. Because it does not agree with any known genus exactly, it is quite probable that it represents an undescribed genus.

Occurrence:—*Hancrania* zone; boulder at 242.

Genus *Lakella* KOBAYASHI, new genus

Type-species:—*Conocoryphe invitus* SALTER, 1859, (Fig. 8g).

Differs from *Conokephalina* and *Westergaardella* in the intramarginal sutures and pitted frontal groove. Very similar to *Yosimuraspis* in cephalon and pygidium, but the glabella is usually furrowed. These furrows are in two pairs in *invita* and *lata*, but in three pairs in *abdita*. Only 12 segments are countable in thorax of *lata*.

Various opinions were expressed on the generic position of the type-species by POMPECKJ (1895), BRÖGGER (1897), REED (1900) and LAKE (1931). As pointed out by BRÖGGER, the pits in the marginal furrow in addition to radial lirae are suggestive of the alliance of *invita* and *abdita*, especially the latter, to the apatokephalids through *Pseudokainella*, but their glabellae taper forward and disconnected from the palpebral lobes at the posterior end.

Distribution:—Late Upper Cambrian of Britain.

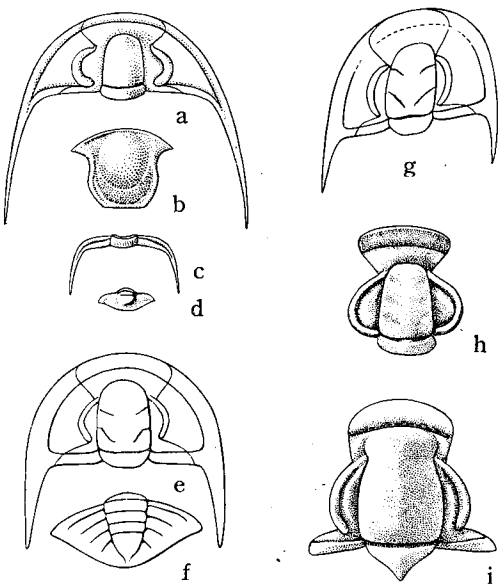


Figure 8. Conokephalinidae and allied genera.

a-d. *Westergaardella olenora* (WESTERGÅRD)
e-f. *Wuhuia dryope* (WALCOTT)
g. *Lakella invita* (SALTER)
h. *Schoriella schorica* SIVOV
i. *Meisterella meisteri* IVSHIN

Genus *Wuhuia* KOBAYASHI, 1933

Type-species:—*Solenopleura belus* WALCOTT, 1905, (Fig. 8e-f).

Wuhuia has the cranidium similar to those of *Lakella* and *Conokephalina* in outline. Lateral furrows are in two pairs in *Wuhuia*, instead of three pairs in *Conokephalina*. *Lakella* differs from this genus in the presence of a row of pits along the marginal furrow of the cranidium.

A geral spine is probably present. It appears broken off from the associated free cheek of *belus* by WALCOTT. Test smooth or granulose.

The pygidium of *dryope* is lenticular like that of *Westergaardella olenorum*, As pointed out already (1931), it is a question whether the rounded pygidium in fig. 12, pl. 13, WALCOTT, 1913 is correctly referred to *belus*.

Distribution:—Late Upper Cambrian; Eastern Asia.

Genus *Schoriella* SIVOV, 1955

1955. *Schoriella* SIVOV in KHALAIN, *Atlas of Important Forms of Characteristic Fauna and Flora of West Siberia, Vol. 1*, p. 133.
1960. *Schoriella* BALASHOV, SUVOROVA and TCHERNYSHEVA, *Principles of Palaeontology*, p. 94.

Type-species:—*Schoriella schorica* SIVOV, 1955, (Fig. 8h).

Remarks:—The cranidium of the type-species resembles *Richardsonella* on one side and *Conokephalina* on the other. Among the Siberian trilobites *Kotuia anomocaroides* KOBAYASHI, 1943, may be the closest to it, but its frontal limb is longer and the anterior facial sutures are more convergent toward the frontal lobe of the glabella. This genus was referred to the Dikelocephalidae by SIVOV and to the Anomocaridae of the Dikelocephaloidea by BALASHOV, SUVOROVA and TCHERNYSHEVA (1960).

The glabella is much shorter and more conical and the preglabellar area much longer on *Schoriella lata* LAZARENKO 1960. At a glance it looks like *Koptura lisani* (WALCOTT), although the glabella is less cylindrical and the frontal limb narrower. The associated pygidium of *S. lata* is quite unusual in its long outline, very narrow pleural lobes and the depressed post-axial spine. This pygidium looks more similar to that of *Kainella* than any pygidium of the Anomocaridae. If the cranidium and pygidium are correctly combined in *S. lata*, it may be said that *S. schorica* is closer to *K. anomocaroides* than *S. lata*.

Schoriella optata TCHERNYSHEVA, 1960, has the cranidium closely resembling that of *S. lata* except the effacement of the lateral glabellar furrows, but the associated pygidium is quite different from that of *lata* and not strange for the Anomocaridae.

Distribution:—Upper Cambrian; Siberia.

Genus *Catuniella* JEGOROVA, 1956

1956. *Catuniella* JEGOROVA, *Material of Palaeontology*, p. 170.
1960. *Catuniella* BALASHOVA. SUVOROBA and TCHERNYSHEVA, *Principles of Paleontology*,

Vol. 8, p. 95.

Type-species:—*Catuniella digna* JEGOROVA, 1956, (Fig. 12m).

The second species is *Catuniella egens* JEGOROVA. Only the cranidium is known of this genus. Like in *Eymekops*, *Haniwa* and their allies, the large palpebral lobes are attached to the glabella. Two distinctive biocharacters of this genus are the expansion of the glabella between the eyes and the convexity of the frontal limb and rim of similar length which are distinctly separated from each other by the marginal furrow.

Distribution:—Late Middle Cambrian; Northeastern Altai.

Genus *Meisterella* IVSHIN, 1953

1953. *Meisterella* IVSHIN, *Middle Cambrian Trilobites from Kazakstan, 1*, p. 160.
1959. *Meisterella* BALASHOVA, SUVOROVA and TCHERNYSHEVA, *Principles of Paleontology, Vol. 8*, p. 95.

Type-species:—*Meisterella meisteri* IVSHIN, 1953, (Fig. 8i).

This is an aberrant trilobite having the large glabella reaching the marginal furrow, obsolete lateral furrows, well developed triangular neck ring, large lunate eyes, and relatively thick convex frontal border. Like *Catuniella* the glabella is expanded between the eye-bands. The rudimentary frontal limb on the two sides of the frontal lobe of the glabella is convex. Therefore this genus appears to be related to *Catuniella* from which it may be derived by the extraordinary growth of the glabella. Its being an extreme off-shoot of this family near *Catuniella* is probable.

Distribution:—Late Middle Cambrian; Kazakstan.

Family Asaphiscidae RAYMOND, 1924

The *Asaphiscus* and *Anomocarella* groups indicate two large branches of of this family flourished respectively on the east and west side of the Pacific province. There are many genera which are different in one or another aspect, but any given two genera often merge from one to the other in some characters without any sharp boundary. Therefore it is not easy to grasp a concrete generic concept.

Here the study is made chiefly on the Asiatic genera through which it was found that none of them is identifiable with *Asaphiscus* s. str. There were several Asiatic species of *Asaphiscus* a few of which are evidently *Anomocarellas* and the others are sufficiently distinct to be separated in the generic rank. On the other hand there are many Asiatic genera which are intimately related to *Anomocarella*. Therefore the Anomocarellinae HUPÉ, 1955, are accepted as a subfamily of the Asaphiscidae.

The Liopariinae, Lioparellinae (nov.) and the Elviniinae are small branches of this family.

Subfamily Asaphiscinae RAYMOND, 1924

Genus *Asaphiscus* MEEK, 1873

1873. *Asaphiscus* MEEK, *6th Ann. Rep. U. S, Geol. Surv. Terr.* p. 485.
1886. *Asaphiscus* WALCOTT, *Bull. U. S. Geol. Surv. No. 30*, p. 219.
1916. *Asaphiscus* WALCOTT, *Smithsonian Misc. Coll. Vol. 64*, p. 381.
1935. *Asaphiscus* RESSER, *Ibid. Vol. 93, No. 5*, p. 12.
1953. *Asaphiscus* HUPÉ, *Ann. de Pal. Tom. 39*, p. 157.
1959. *Asaphiscus* HOWELL, *Treatise on Invert. Pal. Pt. 0-1*, p. 290.

Type-species:—*Asaphiscus wheeleri* MEEK, 1873.

Remarks:—Many American species added by WALCOTT to the genus (1916) were all excluded from the genus by RESSER (1935). Most difficult to understand is RESSER's reference of *Anomocarella* (?) *spatha* MASON, 1935, to *Asaphiscus*, which genus was received his rigorous restriction in next year because this species is a ptychoparioid so different from *Asaphiscus wheeleri* that MASON has compared it with *Armonia*. The broad fixed cheek crossed by a long eye-ridge obviously prevents its confusion with *Asaphiscus*.

In Eastern Asia there are nine species of *Asaphiscus* among which *A. suni* RESSER and ENDO and *A. transversa* RESSER and ENDO having quadrate glabellae are by no means typical of the genus, but they are more likely *Anomocarellas*, s. l. Most other species were recently transferred by CHANG (1959), into *Liaoyangaspis* which is in turn here synonymized with *Pseudoliostracina*.

Original specific name	Present determination
bassleri RESSER and ENDO, 1937, *Asaphiscus*	*Pseudoliostracina*
iddingsi WALCOTT, 1911, *Asaphiscus*	*Pseudoliostracina*
kobayashii RESSER and ENDO, 1937, *Asaphiscus*	*Pseudoliostracina bassleri*
monkei KOBAYASHI, 1935 *Asaphiscus*	*Pseudoliostracina*
peiensis RESSER and ENDO, 1937, *Asaphiscus*	*Pseudoliostracina*
tsutsumii ENDO, 1937, *Asaphiscus*	*Pseudoliostracina*
walcotti RESSER and ENDO, 1937, *Asaphiscus*	*Pseudoliostracina walcotti* *Pseudoliostracina endoi* *Pseudoliostracina wangi*

Distribution:—Middle Cambrian; North America.

Subfamily Anomocarellinae HUPÉ, 1955

This subfamily comprises some 20 Asiatic genera as follows:
Anomocarella WALCOTT, 1905. (*Anomocarella chinensis* WALCOTT)
Dolgaia WALCOTT and RESSER, 1925. (*Dolgaia megalops* WALCOTT and RESSER)
Entorachis KOBAYASHI, 1955. (*Anomocare alcione* WALCOTT)
Holanshania TU (MS) in LU, 1954. (*Holanshania ninghsiaensis* TU in LU)
Honanaspis CHANG, 1959. (*Honanaspis honanensis* CHANG)
Hundwarella REED, 1934. (*Hundwarella personata* REED)
Irania KING, 1937. (*Irania pisiformis* KING)
Iranoleesia KING, 1955. (*Irania pisiformis* KING)

Kaninia WALCOTT and RESSER, 1925. (*Kaninia lata* WALCOTT and RESSER)
Kaniniella SIVOV, 1955. (*Kaniniella alata* SIVOV)
Liaoyangaspis CHANG, 1959. (*Asaphiscus bassleri* RESSER and ENDO)
Manchuriella RESSER and ENDO in KOBAYASHI, 1935. (*Manchuriella typa* RESSER and ENDO)
Metanomocarella CHANG, 1959. (*Metanomocarella rectangula* CHANG)
Orlovia WALCOTT and RESSER, 1925. (*Orlovia arctica* WALCOTT and RESSER
Orloviella LERMONTOVA, 1955. (*Orloviella typa* SIVOV)
Paraorlovia TCHERNYSHEVA, 1956. (*Paraorlovia sequens* TCHERNYSHEVA)
Proasaphiscus RESSER and ENDO in KOBAYASHI, 1935. (*Proasaphiscus yabei* RESSER and ENDO)
Pseudoliostracina KOBAYASHI, 1938. (*Lioparia blauteoides* LORENZ)
Psilaspis RESSER and ENDO in KOBAYASHI, 1935. (*Psilaspis manchuriensis* RESSER and ENDO)
Sunaspis LU, 1953. (*Sunaspis laevis* LU)
Szeaspis CHANG, 1959. (*Szeaspis reticulatus* CHANG)
Thailandium KOBAYASHI, 1957. (*Thailandium solum* KOBAYASHI)

In the boreal or arctic province the group of *Anomocarella* is represented by *Kaninia, Dolgaia, Orlovia, Kaniniella, Orloviella* and *Paraorlovia*, among which I have already given some comments on the former three genera (1935). Recently *Dolgaia* WALCOTT and RESSER, 1924, was made a synonym of *Kaninia* WALCOTT and RESSER, 1924, by BALASHOVA, SUVOROVA and TCHERNYSHEVA (1960). *Kaninia lata* WALCOTT and RESSER, which is the type-species of the genus is diagnostic of *Anomocarella* except for the broad cranidium and fixed cheek in proportion to their length. As pointed out already, *Orlovia* WALCOTT and RESSER, 1924, is intimate to *Manchuriella*, but the cranidium is broader and the genal spine undeveloped in *Orlovia*.

Kaniniella was erected by SIVOV in 1955 with *Kaniniella alata* as its type-species. As noted by him, the species is closely allied to *Kaninia lata* in the general aspect of the cranidium, especially in the broad fixed cheeks and absence of lateral furrows. The glabella is parallelsided in *alata*, but tapering forward in *lata*. Incidentally, the generic name is homonymous with *Kaniniella* KOBAYASHI, 1938.

Orloviella LERMONTOVA, 1955, is represented by *Orloviella typica* and some other species from the late Middle to early Upper Cambrian of Siberia. Compared with *Orlovia*, the fixed cheeks and preglabellar field are narrower, the frontal rim is wider and the palpebral lobe apparently more convex in this genus. In the general outline of the cranidium *Orloviella* may be closer to *Paraorlovia* TCHERNYSHEVA, 1956, (Fig. 9m), but the median casp and radial striae on the preglabellar field readily distinguish *Paraorlovia* from *Orloviella* as well as *Orlovia*,

The above trilobites are either early Upper Cambrian or late Middle Cambrian.

Hundwarella REED, 1934, and *Iranoleesia* KING, 1955 (i.e. *Irania* KING, 1937, non DE FILIPPI, 1863) are two South Asiatic genera of the Anomocarellinae.

Hundwarella personata REED from the *Tonkinella* bed of Kashmir is represented by the cranidia similar to *Manchuriella*, but it has four lateral furrows on the glabella, the posterior two of which branch off inward from the same point. As noted already (1944), a good concept of *Hundwarella* is available from *Conokephalina termieri* MANSUY, 1916, and *C. tienfongensis* MANSUY, 1916.

Iranoleesia pisiformis (KING) (Fig. 9g) fits in *Hundwarella* so nicely that I have considered them congeneric (1944). *Irania falconi* KING (Fig. 9h) is the second species which differs from the precedings in the conical glabella and weak lateral furrows. These two Iranian species occur at separated localities. Their ages are considered by KING to be highest Middle or lowest Upper Cambrian, but there is no other trilobite which confirms this chronology.

Thailandium is a local Fengshanian genus characterized by the truncato-conical glabella, relatively small palpebral lobes at the mid-length of the cranidium, large triangular postero-lateral limb of the fixed cheek and sub-parallel anterior facial sutures.

Sunaspis may be said obsolete *Entorachis*. It is similar to, but different from *Dictyites* in the elevation of the glabella above the cheeks. No linking form is known between early Middle Cambrian *Sunaspis* and late Upper Cambrian *Dictyites*.

Holanshania (Fig. 10a) is an early Middle Cambrian genus most probably of this subfamily, but it can readily be distinguished from all others by a pair of pre-cranial spines issuing from the convex frontal border. In the aspect of the glabellar furrows it resembles *Metanomocarella*.

Before entering into precise discussions on the other Eastern Asiatic genera, a note is given here on some anomocarellids whose dorsal shields are well known. Complete dorsal shields are known of some 15 species of the Anomocarellinae in Eastern and Southeastern Asia among which the number of thoracic segments varies from 9 to 13.

In *Anomocarella chinensis* WALCOTT in fig. 4a, pl. 20, 1913, which RESSER and ENDO (1937) called *Anomocarella blackwelderi* (Fig. 9a) the thorax is composed of 10 segments and the pygidium small, sublenticular and no more than one-ninth as long as the shield.

Szeaspis reticulatus CHANG, 1959, appears to have 10, instead of 9 segments in thorax, but the thorax is composed of 9 segments in *Asaphiscus iddingsi* WALCOTT, 1913, fig. 1, pl. 23, (Fig. 9d), which is referred to *Szeaspis* by CHANG, 1959. In these two species the pygidium is well segmented and one-fourth as long as the shield.

The pygidium has the same proportional length in *Anomocarella temenus* from Mengyin (?) and it is still larger in *Anomocarella* cfr. *temenus* (KOBAYASHI, 1943). These pygidia are essentially similar to those of the preceding two species.

The thorax consists of 11 segments and the pygidium occupies about 1/4 to 1/3.5 of the length of the dorsal shield in *Liaoyangaspis* (*bassleri, walcotti* and *tsutsumii*). The segmentation is generally obsolete in these pygidia and thoracic pleuron is simply pointed in them as well as in *temenus* and cfr. *temenus*, but it is elongated into a spine in the two species of *Szeaspis* and *Anomo-*

carella chinensis.

Proasaphiscus yabei has also 11 segments in thorax, and its pygidium is one-fifth or one-sixth as long as the shield. It is well segmented and rounded in outline, because the anterior margin of the pygidium is strongly arcuate. My *Anomocarella temenus* in 1931 which bears these characteristics must be identified with *Proasaphiscus yabei*.

Hundwarella termieri (MANSUY), 1916, and *H. tienfongensis* (MANSUY), 1916, are different from the above mentioned in the possession of 12 segments in thorax.

Finally, *Honanaspis* has as many as 13 thoracic segments. The pygidium is one-ninth and one-seventh as long as the shield respectively in *H. lui* and *H. honanensis*. *Anomocare minus* by WALCOTT, 1913, figs. 1c-d, pl. 19, having 13 thoracic segments and such a small pygidium, can safely be referred to *Honanaspis*.

Proasaphiscus machidai ENDO, 1937, agrees with *Honanaspis* in the number of thoracic segments, but the thoracic pleuron is produced into a spine as in *Proasaphiscus yabei*. Not only in the relative size but also in the rounded outline this pygidium agrees much better with *Proasaphiscus* than *Honanaspis*.

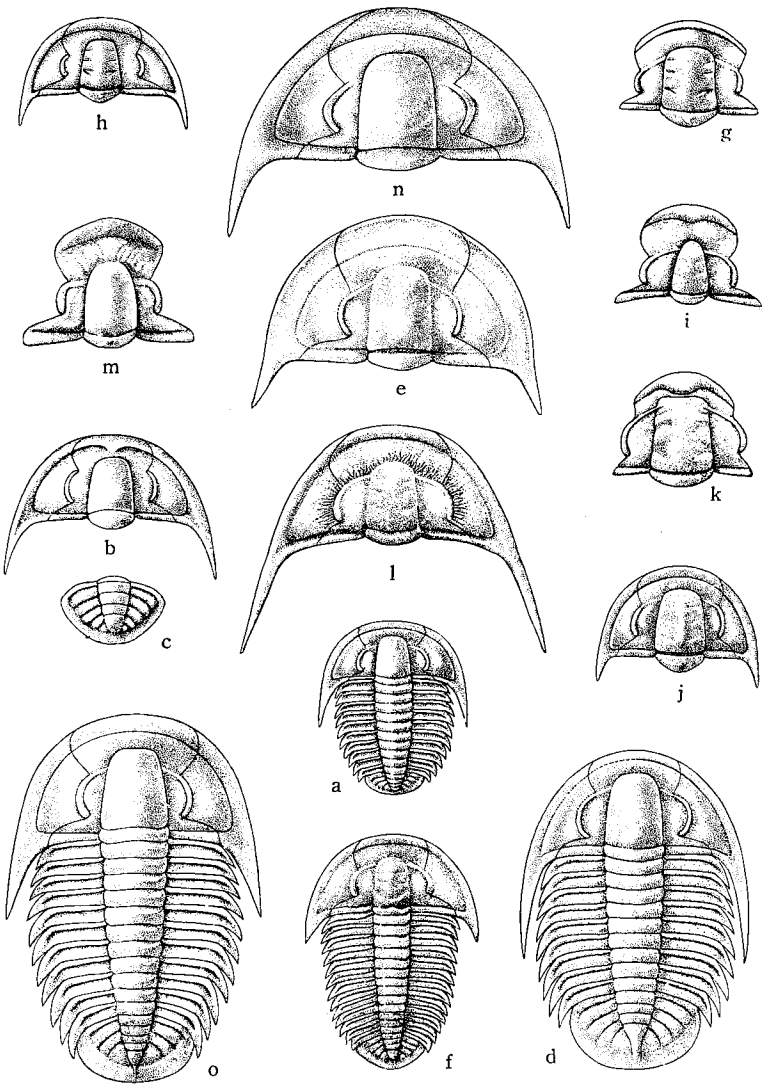
The cranidia or cephala of *Anomocarella*, *Manchuriella* and *Psilaspis*, all having truncato-conical glabellae of moderate size are so similar to one another that it is impossible for me to draw any sharp boundary among them. There is also a wide variation in the strength of the glabellar furrows, prominence of the eye-ridge and the aspects of the marginal border and others. The genal spine is always found on the free cheek in these genera. It is in vain to isolate *Anomocarella chinensis* in fig. 3, pl. 20 from the above general group of trilobites simply by the presence of the median casp of the frontal border. The casp is not even a characteristic which WALCOTT has included in his generic diagnosis.

Metanomocarella is different from *Anomocarella* and its allies primarily in the much greater glabella in proportion to the size of the cranidium and secondarily in the subparallel anterior facial sutures.

Though the variation is gradual, *Entorachis* and *Pseudoliostracina* may be acceptable as subgenera respectively for the cranidium having the cylindrical glabella and that with the conical glabella rounded in front. It is noted further that the anterior sutures are commonly quite marginal in *Entorachis* whereas they are widely intramarginal on the frontal border in *Pseudoliostracina*.

When the complete dorsal shield is known, two groups can be distinguished in the *Anomocarella* group, namely, one with non-falcate thoracic pleurae and the other with falcate ones. The 10-segmented shield of *Anomocarella chinensis* in fig. 4a, pl. 20, WALCOTT, 1913, belongs to the non-falcate group.

Hundwarella inclusive of *Honanaspis* belongs to the same group but has 12 to 13 thoracic segments. *Pseudoliostracina* has 11 thoracic segments and their pleurae are non-falcate, but this genus is quite different from the *Anomocarella* and *Hundwarella* in the much greater pygidium. For the time being *Anomocarella* and *Hundwarella* are recognized to be two branches iso-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lated in the generic rank, because there is no micropygous anomocarellid with 11 thoracic segments and non-falcate pleurae.

The falcate group includes *Proasaphiscus* and *Szeaspis* having respectively 11 to 13 segments and 9 to 10 segments in thorax. The pygidium is smaller in the former and larger in the latter. Because the variation in size of the pygidium and in the number of thoracic segments are gradual, *Szeaspis* is no more than a subgenus of *Proasaphiscus*.

A scheme of classification for Eastern and Southern Asiatic anomocarellids is thus obtained as follows:

I. Non-falcate group
  1. Micropygous subgroup
    Genus *Anomocarella* s. str. (+Subgenus *Entorachis*)..10 thoracic segments
    Genus *Hundwarella* (+*Iranoleesia*, *Honanaspis*)..12-13 thoracic segments
  2. Macrpygous group
    Genus *Pseudoliostracina* (+*Liaoyangaspis*) .....11 segments.

II. Falcate group
  Genus *Proasaphiscus* .....11-13 segments
  Subgenus *Szeaspis*.....9-10 segments

This classification is, however, applicable only to complete shields of trilobites. Most dismembered carapaces are referred here to *Anomocarella* s. l. except for *Metanomocarella*, or some other aberrant genera.

The associated pygidium of the Anomocarellinae is semicircular, semielliptical or sublenticular and surrounded by the depressed entire border of moderate breadth. The pygidium of *Anomocarella tatian* is much longer than any of them; that of *A. tenes* has a shallow posterior sinuation.

All of the complete shields were procured from Middle Cambrian shales. They are flattened and their furrows are weakened to some degrees. The carapaces are dismembered in limestones, but their convexity is often well preserved.

Distribution:—Middle and Upper Cambrian; Asio-boreal province.

Figure 9. Anomocarellinae.

a. *Anomocarella blackwelderi* RESSER and ENDO
b-c. *Anomocarella chinensis* WALCOTT
d. *Asaphiscus iddingsi* WALCOTT
e. *Entorachis alcione* (WALCOTT)
f. *Honanaspis honanensis* CHANG
g. *Iranoleesia pisiformis* (KING)
h. *Iranoleesia falconi* (KING)
i. *Pseudoliostracina bassleri* (RESSER and ENDO)
j. *Manchuriella typa* RESSER and ENDO
k. *Metanomocarella rectangula* CHANG
l. *Szeaspis reticulatus* CHANG
m. *Paraorlovia sequens* TCHERNYSHEVA
n. *Psilaspis manchuricus* RESSER and ENDO
o. *Proasaphiscus yabei* RESSER and ENDO

Genus *Anomocarella* WALCOTT, 1905

1905. *Anomocarella* WALCOTT, *Proc. U. S. Nat. Mus. Vol. 29*, p. 54.
1911. *Anomocarella* WALCOTT, *Smithson. Misc. Coll. Vol. 57*, p. 91.
1913. *Anomocarella* WALCOTT, *Cambrian Faunas of China*, p. 195.
1935. *Anomocarella* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 294.
1935. *Psilaspis* RESSER and ENDO. in KOBAYASHI, *Ibid.* p. 286.
1937. *Anomocarella* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 163.
1937. *Psilaspis* RESSER and ENDO, *Ibid.* p. 268.
1953. *Anomocarella* HUPÉ, *Ann. de Pal. Tom. 39*, p. 119.
1953. *Psilaspis* HUPÉ, *Ibid.* p. 120.
1959. *Anomocarella* HOWELL, *Treatise on Invert. Pal. O-1*, p. 290.
1960. *Anomocarella* BALASHOVA, SUVOROVA, and TCHERNYSHEVA, *Principals of Pal. 8*, p. 94.

Type-species:—*Anomocarella chinensis* WALCOTT, 1905, (Figs. 9b-c).

Remarks:—WALCOTT distinguished this genus from *Anomocare* by the absence of glabellar furrows and the presence of a relatively narrow flattened frontal rim. The lateral sides of the glabella are subparallel, palpebral lobes medium in size and eye-ridges more or less distinct. These aspects of the cranidium are, however, not very sharp distinctions.

Because *Anomocarella* was a comprehensive genus, *Grandioculus, Solenoparia, Eymekops, Metanomocarella* and some other genera must be eliminated from it. RESSER and ENDO emphasized the posterior projection of the frontal rim for the most distinctive character of *Anomocarella*. In consequence, most of WALCOTT's species of *Anomocarella* were excluded from the genus. The projection is, however, not persistent, but its strength varies so greatly even within a species that WALCOTT has included the forms with and without the projection in his *Anomocarella chinensis*, the type-species.

Psilaspis (Fig. 9n) which is simply different from *Anomocarella* on this point was synonymized by the hand of ENDO (1944) with *Manchuriella*, instead of *Anomocarella*. In *Manchuriella* lateral furrows are generally impressed, but they are sometimes discernible only under cross light. The frontal rim is convex in typical *Manchuriella*, but its distinction from *Anomocarella* becomes obscure when the convexity is reduced or the glabellar furrows become obsolete. Therefore *Manchuriella* is no more than a subgenus of *Anomocarella*. *Entorachis* is another subgenus which is distinct from *Anomocarella* in the long cylindrical glabella.

There are a large number of species which have been referred to *Anomocarella*. *Anomocarella baucis* WALCOTT, 1905, and *Anomocare bergeroni* WALCOTT, 1905, are two of them which were procured from the Upper Cambrian of Shantung. The latter is, however, a *Changshanocephalus* and the former a *Changshania*, if not a *Maladioidella*. Thus the two must be eliminated from the genus and all others are Middle Cambrian trilobites.

I have already given some comments on *Anomocarella* (?) *bura* WALCOTT, 1905, and certain species by WALCOTT and LORENZ. RESSER and ENDO (1937) have erected about 10 new species. Subsequently, however, ENDO (1944) found

out the spicific identity of their *blackwelderi, rara, truncata* and *walcotti* with their *distincta* which in turn belonged primarily to *chinensis*. Their *concava* is also said a close ally to *chinensis*. Furthermore their *elongata* could be a laterally compressed *chinensis*, because the glabella and cranidium are both elongated in a smiliar degree.

Anomcarella orientalis ENDO, 1937, and probably *A. huoliensis* ENDO, 1937, belong to *Entorachis; Anomocarella tumida* ENDO, 1944, is a member of *Metanomocarella:* no opinion can be added to *Anomocarella deflacta* ENDO, 1944, and *A. puteata* ENDO, 1944, because of the obscurity of their illustration. *Anomocarella resseri*, KOBAYASHI, 1935, is a distinct species of this genus, but *A. brevifrons* KOBAYASHI, 1935, is now placed in *Entorachis*.

In 1937 RESSER and ENDO splitted *Anomocarella temenus* WALCOTT, into *Psilaspis temenus* and *P. manchuriensis* where the latter was the type-species of their new genus. However, I was quite sceptical of the validity of *Psilaspis* (1935). Later ENDO (1944) united the two species into *Manchuriella temenus*. Assuming this identification to be correct, *Manchuriella*, instead of *Psilaspis*, must loose its standing because *Psilaspis* has the page priority. In my opinion, the closest ally to *Anomocarella temenus* is not *Manchuriella mina* but *A. chinensis*. Therefore *Psilapsis* must be synonymized with *Anomocarella*. Incidentally, *Psilaspis* (?) *convexa* ENDO, 1937, may be said either a *Peishania* with a short conical glabella or a *Grandioculus* whose glabellar furrows are effaced.

Synoptic List of *Anomocarella* and *Psilaspis*

Original specific name	Present determination
albion, WALCOTT, 1905, *Anomocarella*	*Anomocarella* (*Entorachis*)
baucis WALCOTT, 1905, *Anomocarella*	*Changshania* (?)
blackwelderi RESSER and ENDO, 1937, *Anomocarella*	*Anomocarella chinensis*
brevifrons KOBAYASHI, 1935, *Anomocarella*	*Anomocarella* (*Entorachis*)
bura WALCOTT, 1905, *Anomocarella* (?)	*Lisania*
chinensis WALCOTT, 1905, *Anomocarella*	*Anomocarella* (type)
carme WALCOTT, 1905, *Anomocarella*	*Kazelia*
contigua WALCOTT, 1906, *Anomocarella*	*Anomocarella albion*
convexa ENDO, 1937, *Psilaspis*	*Peishania* (?)
convexa RESSER and ENDO, 1937, *Anomocarella*	*Anomocarella* aff. *chinensis*
deflecta ENDO, 1944, *Anomocarella*	?
distincta RESSER aud ENDO, 1937, *Anomocarella*	*Anomocarella chinensis*
elongata RESSER and ENDO, 1937, *Anomocarella*	*Anomocarella chinensis*
hermias WALCOTT, 1911, *Anomocarella*	*Eymekops* (type)
huoliensis ENDO, 1937, *Anomocarella*	*Anomocarella* (*Entorachis*)
irma WALCOTT, 1906, *Anomocarella*	*Anomocarella* (?)
macar WALCOTT, 1911, *Anomocarella*	*Eymekops*
manchuriensis RESSER and ENDO, 1937, (type), *Psilaspis*	*Anomocarella temenus*

orientalis ENDO, 1937, *Anomocarella* .....(*Anomocarella*) (*Entorachis*)
puteata ENDO, 1944, *Anomocarella* .....?
rara RESSER and ENDO, 1937, *Anomocarella*.....*Anomocarella chinensis*
resseri KOBAYASHI, 1935, *Anomocarella* .....*Anomocarella*
shantungensis KOBAYASHI, 1955, *Psilaspis* (*Entorachis*).....
.....*Anomocarella* (*Entorachis*)
shantungensis RESSER, 1942, *Anomocarella* .....*Anomocarella chinensis*
suni RESSER, 1942, *Psilaspis* .....*Anomocarella*
stenorachis KOBAYASHI, 1961, *Anomocarella* .....*Anomocarella*
truncata RESSER and ENDO, 1937, *Anomocarella*....*Anomocarella chinensis*
tumida ENDO, 1944, *Anomocarella* .....*Metanomocarella*
walcotti RESSER and ENDO, 1937, *Anomocarella* ....*Anomocarella chinensis*

Beside these there are 20 species of *Anomocare* (*bergeroni, bigsbyi, biston,* (?) *butus, communz, majus, minus, nanum, ovatum, planum, speciosum, subcostatum* and *temenus*), *Ptychoparia* (*tenes,* and *undata*) and *Ptychoparia* (*Liostracus*) (*subrugosa, thraso, toxeus, trogus* and *tutia*) which were referred to *Anomocarella* by WALCOTT, 1913 and KOBAYASHI, 1937. Among them more than a half belong to this genus as follows:

butus WALCOTT, 1905, *Anomocare* (?)....*Anomocarella* (*Entorachis*) *subquadrata*
commune LORENZ, 1906, *Anomocare*.....*Anomocarella temenus*
comus WALCOTT, 1906, *Ptychoparia*.....*Anomocarella*
majus DAMES, 1883, *Anomocare* .....*Anomocarella*
minus DAMES, 1883, *Anomocare* .....*Anomocarella* (*Manchuriella*) (type)
ovatum LORENZ, 1906, *Anomocare* .....*Anomocarella temenus*
planum DAMES, 1883, *Anomocare*.....*Anomocarella*
speciosum LORENZ, 1906, *Anomocare* ....*Anomocarella*
subcostatum DAMES, 1883, *Anomocare* ..*Anomocarella*
tatian WALCOTT, 1905, *Anomocare* .....*Anomocarella*
temenus WALCOTT, 1905, *Anomocare* ....*Anomocarella*
tenes WALCOTT, 1905, *Ptychoparia* .....*Anomocarella*

For the other species the reader is refered to the synoptic lists of *Anomocare* and *Ptychoparia* on pages 40 and 108.

As already commented on page 82, *Anomocarella* (?) *spatha* MASON, from the Middle Cambrian Cadiz formation of California is a ptychoparioid.

In 1914 WALCOTT referred the following three species from the Levis comglomerate to *Anomocarella* with queries to the second and third species:

1. *Dikelocephalus belli* BILLINGS, 1860
2. *Dikelocephalus oweni* BILLINGS, 1860
3. *Dikelocephalus planifrons* BILLINGS, 1860.

The first species was placed in *Loganellus* by RASETTI, 1944. The second and third species are respectively the type-species of *Levisella* ULRICH, 1930 and *Lauzonella* RASETTI, 1944.

4. *Arionellus* (*Crepicephalus*) *oweni* MEEK and HYDEN, 1861
5. *Crepicephalsu onustus* WHITFIELD, 1878

These two species were referred to *Anomocarella* by WALCOTT in 1916,

but subsequently in 1924 *Modocia* was erected by him for the former, while RESSER (1937) placed the latter in *Coosia*. *Anomocarella smithi* WALCOTT, 1911, is according to RESSER (1935) a member of *Ehmania*. *Anomocarella* (?) *convexa* HOWELL, 1937, is represented by an imperfect free cheek which does not admit me to give any comment.

Distribution:—Middle Cambrian; Eastern Asia.

PA4092-1-8
PA4093-1-9
PA4094-1-10
PA4095-1-11
PA4096-1-26
PA4097-2-6
PA4098-2-16

Anomocarella coreanica KOBAYASHI, new species

Plate I, Figures 8-11, 26, Plate II, Figures 6, 16.

1935. *Anomocarella* cfr. *temenus* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol, 4, Pt. 2*, p. 297, pl. 17, figs. 14, 18-19.

The combination of the detached cranidium, free cheek and pygidium into this species which I suggested in the above paper is probably correct, because the same combination of these parts is found at loc. 109. This cephalon is certainly allied to that of *Anomocarella temenus*, but the pygidium of this species has the postaxial sinuation which is absent in *temenus*. On this account it agrees better with *Anomocarella bigsbyi* (WALCOTT) from which it differs in having a distinct median tubercle on the neck ring and especially in the semi-elliptical outline of the pygidium, prominent post-axial ridge and the nearly uniform breadth of the marginal border.

Occurrence:—*Tonkinella* zone at locs. 109, 201, 219, 293, 304, 306 and Ita 10.

Anomocarella coreanica subsp. *longa* KOBAYASHI, new subspecies

Plate I, Figure 7, Plate II, Figure 17.

PA4099-1-7
PA4900-2-17

The illustrated cranidium and pygidium differ from the typical form primarily in their much longer outlines. Further differences are the improminence of the median tubercle on the neck ring and the backward broadening of the marginal border of the pygidium. The post-axial ridge issues from the axial lobe for some distance inside of the border and terminates at the sinuation.

Occurrence:—*Tonkinella* zone at loc. 109.

Subgenus *Manchuriella* RESSER and ENDO in KOBAYASHI, 1935

1935. *Manchuriella* RESSER and ENDO, in KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 288.
1937. *Manchuriella* RESSER and ENDO, *Bull. Manchur. Sci. Mus. 1*, p. 240.
1953. *Manchuriella* HUPÉ, *Ann. de Pal. Tom. 39*, p. 119.
1959. *Manchuriella* HOWELL, *Treatise on Invert. Pal. 0-1*, p. 291.
1960. *Manchuriella* BALASHOVA, SUVOROVA and TCHERNYSHEVA, *Principles of Pal. 8*, p. 94.

Type-species:—*Manchuriella typa* RESSER and ENDO in KOBAYASHI, 1935, (i. e. *Anomocare minus* by WALCOTT, 1913, pl. 19, figs. 1a-b and *Asaphiscus iddingsi* WALCOTT, 1913, pl. 23, fig. 16). (Fig. 9j).

Remarks:—In 1944 ENDO has identified *Manchuriella prisca* with *Ptychoparia orientalis* and *M. typa*, *M. tapingensis*, *M. distincta* and *M. hatai* with *Manchuriella mina* (DAMES), the opinion being here accepted. The synoptic list of this genus is given below.

Original specific name	Present determination
angustilimbata RESSER and ENDO, 1937, *Manchuriella*	*Szeaspis* (?)
bella RESSER and ENDO, 1937, *Manchuriella* (?)	*Lisania*
convexa KOBAYASHI, 1935, *Manchuriella*	*Manchuriella*
distincta RESSER and ENDO, 1937, *Manchuriella*	*Manchuriella mina*
granulosa ENDO, 1944, *Manchuriella*	*Solenoparia* (?)
hatai RESSER and ENDO, 1937, *Manchuriella*	*Manchuriella mina*
invalida ENDO, 1937, *Manchuriella* (?)	*Inouyella*
marginata RESSER and ENDO, 1937, *Manchuriella* (?)	*Manchuriella*
minaformis KOBAYASHI, 1935, *Manchuriella* (*Blainia* ?)	*Manchuriella*
mukdensis RESSER and ENDO, 1937, *Manchuriella*	?
nodai RESSER and ENDO, 1937, *Manchuriella*	*Manchuriella*
prisca RESSER and ENDO, 1937, *Manchuriella*	*Ptychoparia orientalis*
pustulosa RESSER and ENDO, 1937, *Manchuriella*	*Szeaspis*
shantungensis RESSER, 1942, *Manchuriella*	*Manchuriella*
semicirculare ENDO, 1944, *Manchuriella*	*Manchuriella*
tantilla RESSER and ENDO, 1937, *Manchuriella*	*Manchuriella nodai*
tapingensis RESSER and ENDO, 1937, *Manchuriella*	*Manchuriella mina*
tenuilabrosa ENDO, 1937, *Manchuriella*	*Cyclolorenzella*
tumida RESSER and ENDO, 1937, *Manchuriella*	*Paragraulos* (?)
typa RESSER and ENDO, 1937, *Manchuriella*	*Manchuriella mina*
yenchouensis RESSER, 1942, *Manchuriella*	*Annamitia* (?)

Distribution:—Middle Cambrian; Eastern Asia.

Subgenus *Entorachis* KOBAYASHI, 1955

1955. *Entorachis* KOBAYASHI, *Trans. Proc. Pal. Soc. Japan. N. S. No. 20*, p. 94.

Type-species:—*Anomocare alcione* WALCOTT, 1913, (Fig. 9e).

Remarks:—*Ptychoparia* (*Conocephalites*) *memor* REED, 1910, is another typical species. *Dikelocephalus* (?) *interrupta* REED, 1910, belongs also to this genus. They are Indian species. *Conocephalites subquadratum* DAMES, 1883, is an Eastern Asiatic species with which *Anomocare* (?) *butus* WALCOTT, 1905, is identifiable (1937), insofar as their cranidia are concerned. *Anomocarella albion* WALCOTT, 1905 is another member of this subgenus.

Entorachis was first proposed as a subgenus of *Psilaspis*, when *Psilaspis* (*Entorachis*) *shantungensis* was described. The cylindrical glabella, medium sized eyes and moderate breadth of fixed cheeks are important characteristics

of this subgenus. It can easily be distinguished from *Haniwa* by smaller eyes. The outline of the cranidium is not contracted at eyes as in American *Wilbernia*.

Distribution:—Middle Cambrian; Eastern and southern Asia.

PA4101-1-13
PA4102-5-21
PA4103-5-22

Anomocarella (*Entorachis*) *brevifrons* KOBAYASHI, 1935

Plate I, Figure 13; Plate V. Figures 21–22.

1935. *Anomocarella brevifrons* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 297, pl. 17, figs. 10–13.

Detailed description has been given on the previous occasion. Its comparison was made with *Entorachis memor* and *E. interrupta*. *E. subquadratum* is also very similar to this species, but lateral furrows on the glabella are stronger and the fixed cheeks narrower.

Occurrence:—*Tonkinella* zone at loc. 109; *Eochuangia* zone at locs. 258 and 262.

PA4104-4-18
PA4105-4-19

Anomocarella (*Entorachis*) *longifrons* (KOBAYASHI), 1935

Plate IV, Figures 18a-b, 19.

1935. *Lioparia* (?) *longifrons* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 241, pl. 17. fig. 15.

The broad cranidium, short quadrate glabella, wide fixed cheeks, relatively small eyes connected with the glabella by eye-ridges, extensive frontal limb, convex frontal rim and slightly diverging anterior facial sutures are all characteristics of this species. In the specimen from loc. 228 lateral furrows are seen on the right side of the glabella, but not on the other. The difference depends upon the strength of secondary deformation. A small free cheek from the same locality has a short spine. The cephalon figured with them is intimately related to *E. brevifrons*, if the relative length between the frontal limb and the glabella is overlooked.

Occurrence:—*Eochuangia* zone of Locs. 228 and 271.

PA4106

Anomocarella (*Entorachis*) *gracilis* KOBAYASHI, new species

Plate V, Figure 7.

This species has many characters common with *Anomocarella* (*Entorachis*) *brevifrons*, but it can be easily distinguished from that species by the well rounded anterior margin of the glabella and the median depresseion on the frontal limb. The limb is broader than the frontal rim in this species, while the reverse is the case of *E. brevifrons*. Three pairs of lateral furrows are well marked on the glabella, but all very narrow, the anterior and middle ones of which are transversal and the posterior ones diagnonal. The occipital

furrow is strong and the occipital ring narrow and strongly bowed backward. The eyes are a little larger than those of *A.* (*E.*) *brevifrons*. The proportional breadth of the fixed cheek to the glabella is not much different between the two species.

Occurrence:—Black shale of Machari formation at loc. 256.

PA4107

Anomocarella (*Entorachis*) sp. nov.

Plate II, Figure 4.

The cylindrical glabella is quite suggestive of *Entorachis* for this cranidium. Lateral furrows are obscure and the occupital furrow is weak, but the axial carination is distinct. The neck ring carries a prominent median turbercle. Like in *E. gracilis* the anterior outline of this glabella is rounded. The frontal limb and rim are equal in length; the former depressed and the latter strongly convex. Unfortunately the fixed cheeks are imperfect to give a new name for this cranidium.

Occurrence:—*Tonkinella* zone at loc. 105.

Genus *Metanomocarella* CHANG, 1959

1959. *Metanomocarella* CHANG, *Acta Pal. Sinica, Vol. 7, No. 3*, pp. 195, 217.

Type-species:—*Metanomocarella rectangula* CHANG, 1959, (Fig. 10k).

Remarks:—Similar to *Anomocarella*, but the glabella is considerably larger in comparison with the cranidium. Accordingly the fixed cheeks and frontal limb are all very narrow.

In the type-species lateral furrows are distinctly impressed on the glabella and the frontal rim and limb are both convex where the former is protruded back into the latter. This aspect is also seen in *Aojia tumida* RESSER and ENDO, 1937, which was referred to this genus by CHANG. *Anomocarella tumida* ENDO, 1944, is also not the less allied to the type-species. The glabellar furrows are, however, much obsolete in the second and third species.

Here the generic domain is considered wider to include *Ptychoparia nereis* WALCOTT, 1906, and *P. undulata* WALCOTT, 1906, in which the frontal limb is depressed and the facial sutures are divergent forward from the eyes.

Distribution:—Middle Cambrian (Taitzuan in main) in Eastern Asia.

Genus *Hundwarella* REED, 1934

Subgenus *Honanaspis* CHANG, 1959

1959. *Honanaspis* CHANG, *Acta Pal. Sinica, Vol. 7, No. 3*, pp. 204, 226.

Type-species:—*Proasaphiscus* (*Honanaspis*) *honanensis* CHANG, 1959, (Fig. 9f).

Honanaspis having 13 segments in thorax was erected by CHANG as a subgenus of *Proasaphiscus*. He is of opinion that its gap in the number of thoracic segments from *Proasaphiscus* s. str. having 11 segments is filled with

Hundwarella (*termieri* and *tienfongensis*) having 12 segments.

He noted further that *Manchuriella* is perhaps no more than a subgenus of *Proasaphiscus*. One of WALCOTT's specimens of *Anomocare minus* (pl. 19, figs. 1c-d, 1913) which has 13 segments and a small and broad pygidium is typical of *Honanaspis*, but it appears not a true *minus*.

Distribution:—Middle Cambrian (Tangshihan); Liaoning, Shantung and Honan.

Hundwarella (*Honanaspis*?) *matsushitai* KOBAYASHI, new species

Plate XII, Figures 1a-b; Text-figure 10.

1913. Comp. *Anomocare minus* WALCOTT, *Cambrian Faunas of China*, p. 192, pl. 19, figs. 1c-d.

This species is represented by a nearly complete dorsal shield having 13 segments in thorax. The cranidium and pygidium occupy about 2/9 and 1/12 of the length of the shield respectively; axial lobe narrowing backward more rapidly than the outline of thorax; pleural furrow distinct; pleural end subtruncated; pygidium surrounded by a narrow and depressed border; its segmentation quite obsolete.

Compressed laterally, the preglabellar field and other parts are wrinkled, lateral furrows of the glabella obscured and the anterior outline of the glabella presumably becomes more rounded than it has primarily been. In considering that the pygidium has had a broader outline before deformed, this species is closely allied to WALCOTT's *Anomocare minus* in figs. 1c-d which was collected from a shale of the lower Fuchou series in Tschanghsingtau.

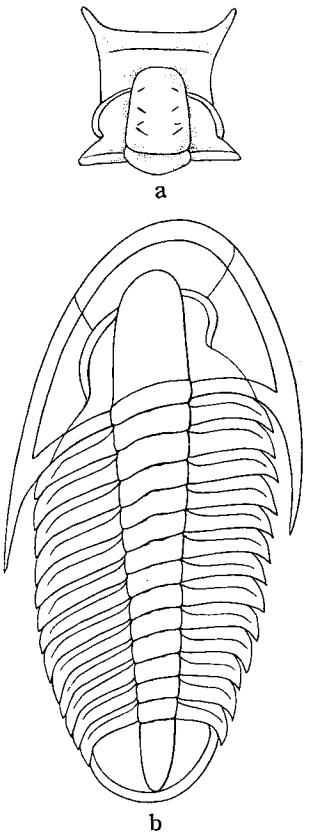


Figure 10. Anomocarellinae.
a. *Holanshania ninghsiaensis* TU, (MS) in LU
b. *Hundwarella matsushitai* KOBAYASHI, n. sp.

The glabella is more quadrangular in other species of *Honanaspis*. In the obsolete glabellar furrows and the outlines of the cranidium and pygidium this species is most allied to *Proasaphiscus machidai* ENDO, but the thoracic pleurae are strongly falcate and elongated into spines in that species. In regard to the thoracic pleuron it agrees better with *H. honanensis* CHANG, but in that species the facial sutures are subparallel in front of the eyes and

intramarginal for some distance on the border and the pygidium is sublenticular in outline and most distinctly segmented in this subgenus.

Occurrence:—Tangshihan green shale at a point about 3 km north of Peimen (North gate) of Chinchou, (Loc. 4). I have collected this specimen in my first visit to Manchuria in spring, 1927, when MATSUSHITA was at the Engineering College of Ryojun (Port Auther) and guided me in a short trip to Sanshihlipu and Chinchou. It is my pleasure to denominate this new species in honour of Prof. Susumu MATSUSHITA of the Kyoto University.

Genus *Pseudoliostracina* KOBAYASHI, 1938

1938. *Pseudoliostracina* KOBAYASHI, *Jour. Geol. Soc. Japan, Vol. 45*, p. 889.
1959. *Liaoyangaspis* CHANG, *Acta Pal. Sinica, Vol. 7, No. 3*, pp. 197, 219.

Type-species:—*Lioparia bautoeides* LORENZ, 1906.

Diagnosis:—Cranidium with conical unfurrowed glabella, medium sized palpebral lobes, prominent eye-ridge crossing fairly wide fixed cheeks and their long postero-lateral limbs; frontal limb broad; preglabellar axial furrow sometimes present; marginal border of moderate thickness and genal spines usually present; anterior facial sutures slightly divergent; thorax composed of 11 segments; pygidium a little shorter than cephalon and poorly segmented; axis narrow; marginal border broad.

Remarks:—The genus was primarily defined by "its narrow conical glabella, deep axial furrows joining with each other at the pointed glabellar front and then running across the frontal limb, medium sized eye, fixed cheek which is wider than the glabella and crossed by the eye-ridge, and tolerably developed frontal border." The diagnosis is here emended as above.

Asaphiscus bassleri RESSER and ENDO, 1937, (Fig. 9i), which is the type-species of *Liaoyangaspis* fits in the diagnosis so well that its congenity with *L. bautoeides* is quite warranted. The two species are, however, a little different in the strength of the preglabellar median furrow and the divergence of the anterior facial sutures. According to ENDO (1944) *Asaphiscus kobayashii* RESSER and ENDO, 1937, from the Taitzuan belongs to an identical species with *A. bassleri* from the Tangshihan series. CHANG (1959) referred the following species to *Liaoyangaspis*.

Asaphiscus peiensis RESSER and ENDO, 1937
Asaphiscus tsutsumii RESSER and ENDO, 1937
Asaphiscus walcotti RESSER and ENDO, 1937
Liaoyangaspis endoi CHANG, 1959
Liaoyangaspis wangi CHANG, 1959

The complete dorsal shields of *bassleri* and a few other species show that they are isopygous trilobites carrying genal spines and 11 thoracic segments. Through these species it is found further that the strength of the median furrow and the angle between the anterior sutures vary continuously, but the glabella is always conical and the glabellar furrows are obsolete, eye-ridges oblique and posterior-lateral limbs of fixed cheeks well developed. The pre-

sence of the median furrow is no more an important characteristic.

Asaphiscus monkei KOBAYASHI, 1937, from the *Prochuangia* zone of South Korea may be the latest survivor of the genus.

Distribution:—Middle Cambrian (Tangshihan and Taitzuan) and early Upper Cambrian; Eastern Asia (Shantung Liaoning and South Korea.

Genus *Proasaphiscus* RESSER and ENDO, in KOBAYASHI, 1935

1935. *Proasaphiscus* RESSER and ENDO in KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 287.
1937. *Proasaphiscus* RESSER, and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 256.
1953. *Proasaphiscus* HUPÉ, *Ann. de Pal. Tom. 39*, p. 157.
1957. *Proasaphiscus* LU, *Index Fossils of China, Invert. Vol. 3*, p. 267.
1959. *Proasaphiscus* HOWELL, *Treatise on Invert. Pal. Pt. 0-1*, p. 292.
1960. *Proasaphiscus* BALASHOV, SUVUROVA and TCHERNYSHEVA, *Principles of Pal. Vol. 8*, p. 96.

Type-species—*Proasaphiscus yabei* RESSER and ENDO in KOBAYASHI, 1935.

Remarks:—RESSER and ENDO placed 9 species from the Tangshihan inclusive of the Mapanian series and 16 Taitzuan species in *Proasaphiscus* which were all new species except for *Anomocare ephori* WALCOTT. They are mostly represented by dismembered carapaces, but the complete shields are known of the three Tangshihan species. *Proasaphiscus yabei* RESSER and ENDO, *P. huoliensis* ENDO and *P. machidai* ENDO have 11, 12 and 13 segments in the thorax respectvely.

A. ephori may be accepted as a *Proasaphiscus* only from the apparent similarities of the cranidium. Likewise CHANG's reference of *P. centronotus* to *Szeaspis* is also tentative. Incidentally ENDO (1944) synonymized *P. planus* RESSER and ENDO with *centronotus*. *Proasaphiscus* (?) *tschanghsingensis* RESSER and ENDO is fairly well isolated from other species by the remarkably concave preglabellar field. *Proasaphiscus liaoyangensis* RESSER and ENDO has the more normal cranidium for *Proasaphiscus*. The cranidium of *P. paotaiensis* RESSER and ENDO is very imperfectly preserved.

Among the Taitzuan species it is certain that *P.* (?) *conoides* RESSER and ENDO must be excluded from the *Anomocarella* group. The short conical glabella, very large preglabellar area and the narrow frontal rim suggest the great possibility of its being number of the Bowmaniinae. *Proasaphiscus granulatus* ENDO is another aberrant form remarkably resembling *Lioparia*. Still another isolated form is *P. quadraticaudatus* ENDO having the quadrate pygidium. It is noted further that *P. humilis* RESSER and ENDO, *P.* (?) *pyriformis* RESSER and ENDO and *P. quadrilateralis* RESSER and ENDO in which the glabella is elongated as far as the frontal rim cannot be retained in the *Anomocarella* group.

Because the Taitzuan species are all represented by fragmentary materials, it is difficult to give any further comments, but the remaining species listed below are in the domain of the *Anomocarella* group.

Proasaphiscus affluensens RESSER and ENDO, 1937
Proasaphiscus kimurai RESSER and ENDO, 1937
Proasaphiscus (?) *mantouensis* RESSER and ENDO, 1937
Proasaphiscus offula RESSER and ENDO, 1937
Proasaphiscus pertensis RESSER and ENDO, 1937
Proasaphiscus planilimbatus ENDO, 1944
Proasaphiscus poulseni RESSER and ENDO, 1937
Proasaphiscus tenellus RESSER and ENDO, 1937
Proasaphiscus (?) *tenuicaudatus* RESSER and ENDO, 1937
Proasaphiscus willisi RESSER and ENDO, 1937

Proasaphiscus suni LU, 1945, from the early Middle Cambrian Kaotai limestone of Meitan, Kueichou has the fixed cheeks unusually broad for *Proasaphiscus*. As the author compared his species with *Elrathia* and *Anomocare*, it is by no means diagnostic of the genus. Finally, *Proasaphiscus sibiricus* TCHERNYSHEVA, 1950 (1960) and *P. clarus* TCHERNYSHEVA, are also represented by dismembered carapaces. The former has a median tubercle on the occipital ring, like *P.* (?) *tenuicaudatus*.

Distribution:—The Tangshihan and (?) Taitzuan; Liaoning, (?) Kueichou and Shiberia.

Proasaphiscus yabei RESSER and ENDO in KOBAYASHI, 1935

PA4110

Plate XII, Figure 3, Text-figure 9o.

1935. *Proasaphiscus yabei* RESSER and ENDO in KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo. Sec. 2, Vol. 4, Pt. 2*, pl. 24, fig. 16.
1937. *Proasaphiscus yabei* RESSER and ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 257, pl. 41, figs. 17-21.
1957. *Proasaphiscus yabei* LU, *Index of Fossils of China, Invert. Vol. 3*, p. 267, pl. 142, figs. 1-2.

The specific diagnosis is given in detail by RESSER and ENDO, except for one misobservation that the thorax of this species is composed of 11, instead of 10 segments as stated by them.

Occurrence:—Tangshihan of Liaoning and Shantung. The illustrated specimen was procured from the Tangshihan chocolate shale near Huaiyao, Yentai coal-field, Liaoning.

Proasaphiscus huoliensis ENDO, 1937

PA4111

Plate XII, Figure 2.

1937. *Proasaphiscus huoliensis* ENDO, *Manchurian Sci. Mus. Bull. 1*, p. 59, pl. 16.

The pygidium and cephalon are imperfect in the specimen before hand, but it agrees best with *Proasaphiscus yabei* except for the number of thoracic segments which are countable 12.

Occurrence:—Tangshihan of Liaoning. The present specimen was collected from a chocolate shale at Hueiyao, Yentai coal-field, Liaoning.

Subgenus *Szeaspis* CHANG, 1959

1959. *Szeaspis* CHANG, *Acta Pal. Sinica, Vol. 7, No. 3*, p. 207, 229.

Type-species:—*Szeaspis reticulatus* CHANG, 1959, (Fig. 9l).

Diagnosis:—Dorsal shield with 9 or 10 segments in thorax; glabella tereto-conical, subrounded anteriorly, provided with three pairs of weak lateral furrows; eye-band and eye-ridge describe a quarter of a circle of moderate size; frontal limb equal to or slightly greater than frontal rim in length; free cheek with a long genal spine; anterior facial suture diagonal to the axis in front of the eye and diagonal on the frontal border for a long distance. Pleural spine of thoracic segment long; pygidium medium in size, broad; axial lobe produced into a post-axial ridge; pleural furrow running into marginal border.

Remarks:—Beside the type-species and its variety, *brevis* CHANG, 1959, the author referred the following three species to this genus:

Asaphiscus iddingsi WALCOTT, 1911

Manchuriella pustulosa RESSER and ENDO, 1937

Proasaphiscus centronatus RESSER and ENDO, 1937

Anomocare flava WALCOTT (fig. 8b, pl. 18, 1913) reveals good agreement with the type species.

The thorax is composed of 9 segments in the complete shield of *iddingsi* (fig. 1, pl. 23, WALCOTT, 1913), but the type-species appears to have 10 thoracic segments, insofar as they are countable on the shield in fig. 8a, pl. 3, CHANG, 1959.

Distribution:—Tangshihan (Mapanian) and Taitzuan in Liaoning, Shantung and Shansi.

Subfamily Lioppariinae KOBAYASHI, 1960

Genus *Changshanocephalus* SUN, 1935

1960. *Changshanocephalus* KOBAYASHI, *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 12, Pt. 2*, p. 394. (See for synonymic references).

Crepicephalus chinchiaensis ENDO, 1937, (Fig. 11b), from the Daizanian of Liaoning is represented by the cranidium referable to this genus. The broad depressed frontal border and narrow frontal limb reveal the distinctive characters of this species.

Subfamily Lioparellinae KOBAYASHI, new subfamily

This is a group allied to *Anomocarella*, but excluded from the Anomocarellinae by the cranidium and fixed cheeks which are much broader than usual in the Anomocarellinae. The glabella is generally conical and truncated anteriorly. Its size is moderate; lateral furrows may be present or absent; palpebral lobes mostly medium or small and connected with the glabella by eye-ridges; frontal limb and rim separated by a marginal furrow; free cheeks a

little broader than fixed cheeks through eyes and carrying genal spines; facial sutures diagonal behind the eyes and less divergent or subparallel anteriorly. It includes the following genera:

Koptura RESSER and ENDO, in KOBAYASHI, 1935. (*Anomocare lisani* WALC.)
Lioparella KOBAYASHI, 1937. (*Lioparella walcotti* KOBAYASHI, Fig. 11d)
Chelidonocephalus KING, 1937. (*Chelidonocephalus alifrons* KING, Fig. 11f)
Pedinocephalus IVSHIN, 1955. (*Pedinocephalus bublichenkoi* IVSHIN, Fig. 11m)
Wutingshania CHU, 1959. (*Wutingshania lui* CHU)
Pedinocephalina ROSOVA, 1960. (*Pedinocephalina bella* ROSOVA)

Koptura and *Wutingshania* are not diagnostic of the subfamily respectively in the cylindrical glabella and large eye-bands.

Distribution:—Late Middle (?) and Upper Cambrian; Asia.

Genus *Lioparella* KOBAYASHI, 1937

1935. *Lioparia* KOBAYASHI, (non LORENZ, 1906). *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 239.
1937. *Lioparella* KOBAYASHI, *Jour. Geol. Soc. Japan, Vol. 44*, p. 429.
1959. *Lioparella* HOWELL. *Treatise on Invert. Pal. 0-1*, p. 291.

Type-species:—*Lioparella walcotti* KOBAYASHI, 1937, i. e. *Anomocarella latelimbatum* by WALCOTT, 1911, (non DAMES, 1883), in figs. 2d and 2e, pl. 16, (Fig. 11d).

Remarks:—Through the revision of DAME's type trilobites from Liaoning it was found that *Anomocare latelimbatum* on which LORENZ (1906) has founded *Lioparia* is an early Upper Cambrian trilobite congeneric with *Yokusenia vulgaris* KOBAYASHI, 1935, but quite distinct from WALCOTT's *latelimbatum* from the Middle Cambrian in Shantung. Therefore *Lioparella* was erected for WALCOTT's *latelimbatum*, in denominating this species as *Lioparella walcotti* and refering *Lioparia expansa* KOBAYASHI, 1935, to this new genus. *Anomocare propinquum* MANSUY, 1919, is a member of this genus.

The chief generic characters are the short conical glabella, large frontal limb, relatively narrow frontal rim, wide fixed cheeks and medium sized posterior eyes provided with eye-ridges. Associated pygidium relatively small, pleural furrows running into a flat marginal border.

Distribution:—Late Middle Cambrian; Eastern and Southeastern Asia.

Lioparella longifolia KOBAYASHI, new species

PA4112

Plate I, Figure 20a-b.

The most distinct feature of this species is the considerably developed preglabellar field which is nearly as long as the glabella. Compared to this species, the field is much shorter in *walcotti* and *expansa*. The frontal rim is on the contrary, very narrow in this species. The glabella is conical and rounded in front. The long glabella and its strong axial keel suggest that the type cranidium is secondarily compressed laterally to some degrees, causing

obliteration of the lateral furrows. Palpebral lobes are fairly large and probably intermediate in size between those of *walcotti* and *expansa*. Eye-ridges are distinct and comparatively thick.

Occurrence:—*Tonkinella* zone at loc. 105.

Genus *Koptura* RESSER and ENDO, 1935

1935. *Koptura* RESSER and ENDO in KOBAYASHI. *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, pp. 278, 288.
1937. *Koptura* RESSER and ENDO, *Manch. Sci. Mus. Bull. 1*, p. 235.
1953. *Koptura* HUPÉ, *Ann. de Pal. Tom. 39*, p. 158.
1959. *Koptura* HOWELL, *Treatise on Invert. Pal. O-1*, p. 288.
1960. *Koptura* BALASHOV, IVSHIN and TCHERNYSHEVA, *Principles of Pal. 8*, p. 93.

Type-species:—*Anomocare lisani* WALCOTT, 1911 (Fig. 11k-l).

Remarks:—The cephalon of *lisani* agrees with that of *Lioparella walcotti* in the short glabella, broad preglabellar field, narrow frontal rim, thick doublure which is often impressed on the dorsal side and some other features. The glabella is, however, evidently more cylindrical and slender and the doublure much broader in *Koptura*. The angle between the lateral and posterior marginal furrows is acute in *walcotti* but apparently rounded in *lisani*. The associated pygidium of *lisani* is bilobed. These lobations are made by the posterior prolongation of the marginal border. When exfoliated, the doublure is found very broad.

Unless the part called "very wide and concave rim" is a pseudo-border impressed by the thick doublure, *Koptura granosa* RESSER and ENDO is quite distinct from *lisani*. The cranidium of *Koptura quadrata* ENDO, 1937, looks like a normal one of *Manchuriella*, although the associated pygidium has a shallow sinuation behind the axis. HENNINGSMOEN (1957) referred *Koptura* (?) *pachecoi* R. and E. RICHTER, 1940 to *Eops eo* RICHTERS, 1940 with query.

A pygidium of *Koptura lisani* from Tschanghsingtao is illustrated in fig. 18, pl. IX.

Distribution:—Kushanian; Eastern Asia.

PA4113-7-1
PA4114-7-2
PA4115-7-3
PA4116-7-4
PA4117-7-5
PA4118-7-6
PA4119-7-7

Koptura bispinata KOBAYASHI, new species

Plate VII, Figures 1-7.

Description:—Glabella longer than two-thirds the cranidium, subcylindrical, slightly tapering forward, more or less rounded in front, gently convex and provided with two pairs of oblique lateral furrows; occipital ring narrow; palpebral lobes medium in size, opposed to the middle of glabella; eye-ridge distinct; fixed cheek narrower than glabella at eyes; frontal limb flattish, or slightly convex; marginal border narrow, convex and elevated; anterior facial sutures gradually divergent from eyes and obliquely crossing frontal border; posterior ones diagonal.

Pygidium exclusive of spines elliptical; axial lobe as broad as one-third

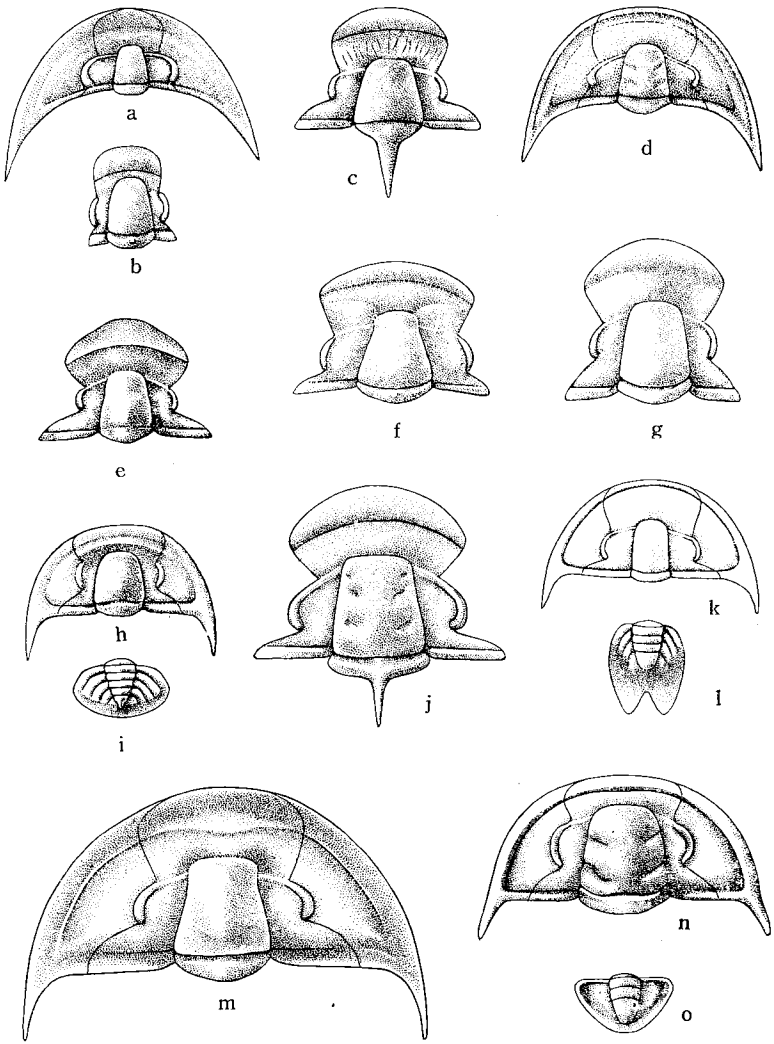


Figure 11. Lioppariinae, Lioparellinae and Idahoiinae.

a. *Wutingshania lui* CHU
b. *Changshanocephalus chinchiaensis* (ENDO)
c. *Idahoia angulata* KING
d. *Lioparella walcotti* KOBAYASHI
e. *Maladioidella splendens* (ENDO)
f. *Chelidonocephalus aliforns* KING
g. *Olentella olentensis* IVSHIN
h–i. *Taishania taianensis* SUN
j. *Iranella latifrons* (KING)
k–l. *Koptura lisani* (WALCOTT)
m. *Pedinocephalus bublichenkoi* IVSHIN
n–o. *Maladioides asiaticus* KOBAYASHI

the pygidium, conical, composed of five rings and a terminal lobe; pleural lobe divided into five ribs by deep furrows; marginal brim flat and protruded into a pair of large flat posterior spines.

Comparison:—This species can easily be distinguished from *Koptura lisani* by the larger glabella, narrower fixed cheek and broader pygidium. RESSER and ENDO erected *Temnura granulosa* for a similar pygidium in which however, the pleural ribs and furrows run into the posterior spines. In *Koptura* on the other hand the flat spine is the extension of the marginal border.

The pygidium of this species is similar also to that of *Mesocrepicephalus subquadratus*, although the latter has more segments and the spines are smaller. The pygidium of *Mesocrepicephalus airaghii* reveals some resemblances with this pygidium, but their cranidia are quite different from each other.

Occurrence:—*Koptura* shale at locs. 197, 199 and 313.

Koptura cfr. *bispinata* KOBAYASHI, 1961

Plate X, Figure 12. PA4120

A large pygidium agrees with the preceding pygidium in essential characteristics, but it looks more elliptical in general outline and the flat posterior spine is much larger. Whether it reveals a grown stage of the same species, or whether the morphic difference bears taxonomic value is however, a question.

Occurrence:—Black shale at loc. 199.

Genus *Wutingshania* CHU, 1959

1959. *Wutingshania* CHU, *Mem. Inst. Pal. Acad. Sinica, No. 2*, pp. 73, 117.

Type-species:—*Wutingshania lui* CHU, 1959, (Fig. 11a).

Remarks:—This genus is well characterized by the short truncato-conical unfurrowed glabella, large palpebral lobes connected with the glabella, by distinct horizontal eye-ridges, large concave preglabellar field, broad frontal border where the sutures are intramarginal and the free cheek provided with a large spine. The doublure is about a half broader than the marginal border. It differs from *Haniwoides* in the long eye-ridge traversing the broad fixed cheek. In my opinion it is more allied to either *Lioparella* or *Koptura*, although the palpebral lobes are larger than those of the two allies. The isoteli-form suture is also very distinctive of this genus.

Distribution:—Kushanian; Liaoning.

Subfamily Elviniinae KOBAYASHI, 1935

Beside *Maladioides*, (Fig. 11n-o) this subfamily is represented in Eastern Asia by *Taishania* SUN, 1935, (Fig. 11h-i) and probably by *Maladioidella* ENDO, 1937. It is possible that *Anomocare persicum* KING, 1930, from the Upper Cambrian of Iran reveals an undescribed genus of this subfamily by itself. The following

three genera are considered by BALASHOVA, IVSHIN and TCHERNYSHEVA (1960) to be the members of this family in Kazakstan and Novaja Zemlya.

Kujandina IVSHIN, 1955 (*Kujandina taskudukensis* IVSHIN)

Olentella IVSHIN, 1955 (*Olentella olentensis* IVSHIN, Fig. 11g)

Pesaia WALCOTT and RESSER, 1924 (*Pesaia exsculpta* WALCOTT and RESSER)

Distribution:—Upper Cambrian; cosmopolitan (?).

Genus *Maladioidella* ENDO, 1937

1937. *Maladioidella* ENDO, *Manch. Sci. Mus. Bull. 1*, p. 346.
1953. *Maladioidella* HUPÉ, *Ann. de Pal. Tom. 39*, p. 167.
1959. *Maladioidella* LOCHMAN-BALK, *Treatise on Invert. Pal. 0-1*, p. 260.

Type-species:—*Maladioidella splendens* ENDO, 1937, (Fig. 11e).

Remarks:—The outline of the cranidium is strongly contracted at the eyes. The glabella is truncato-conical and medium in size; palpebral lobe relatively small, eye-ridge distinct and oblique, frontal rim broad, flat and narrowing laterally in the type-species from the Daizanian of Liaotung.

The second species is *M. convexolimbata* ENDO, 1937 from the same formation as the type-species, but it has a more conical glabella, strong posterior and dorsal furrows. The frontal border is divided into a narrow rim and wide depression behind the rim, which is expanded back toward the frontal lobe of the glabella. The aspect reminds one of *Chelidonocephalus*.

The third species is *M. elonganta* ENDO, 1944, from the *Chuangia* zone whose glabella is subcylindrical and angulated in anterior. The palpebral lobe is larger than that of the type-species. Where the generic boundary is properly drawn is, however, still a question.

Anomocarella baucis WALCOTT, 1905, from the *Tsinania* zone (?) of Shantung is closely related to the preceding, but the facial sutures anterior to the eyes are nearly parallel to each other.

Distribution:—Daizanian of Liaotung; (?) whole Upper Cambrian of Eastern Asia.

Subfamily Idahoiinae LOCHMAN, 1956

Previously I have combined *Liostracus*, *Grönwallia*, *Saratogia* and *Idahoia* into the Liostracinae. While the former two are Paradoxidian genera, the latter two are Croixian ones. In 1956 LOCHMAN erected Idahoiidae for Franconian-Trempealeauan branch including the latter two genera, which she thinks to have been derived from an unknown ptychopariid ancester during the Dresbachian age.

There are no resembling trilobites in Eastern Asia, but thier allied species are described by KING (1937) from the Upper Cambrian of Iran as follows:

1. *Idahoia angulata* KING, (Fig. 11c).
2. *Idahoia* cfr. *maladensis* WALCOTT.
3. *Saratogia latifrons* KING, (Fig. 11j).

HUPÉ created *Iranella* for the last species, but he located this new genus in the same family with *Saratogia*, *Idahoia* and some other genera. One of them was *Annamitia* MANSUY, 1916, from the late Middle Cambrian of Southeastern Asia which bears many common characters with those genera, but the subparallel anterior facial sutures casts a question on the subfamily-reference.

Morphologically, *Liostracus platyrrhina* GRÖNWALL from the Andrarum limestone which is the type-species of *Grönwallia* KOBAYASHI, 1935, is certainly not the less similar to these Idahoiinae genera than *Andrarina costata* (ANGELIN), the type-species of *Andrarina* RAYMOND, 1937, i.e. *Liostracus* ANGELIN, 1854, non ALBERS, 1850.

How much weight should be laid on phylogeny, for the morphic resemblances among these genera which are geologically or geographically isolated, however, belong to a future problem.

Distribution:—Middle (?) and Upper Cambrian; cosmopolitan?

Subfamily Coosellinae PALMER, 1954

Genus *Coosia* WALCOTT, 1911

Coosia (?) sp. indt.

Plate III, Figure 24.

PA4121

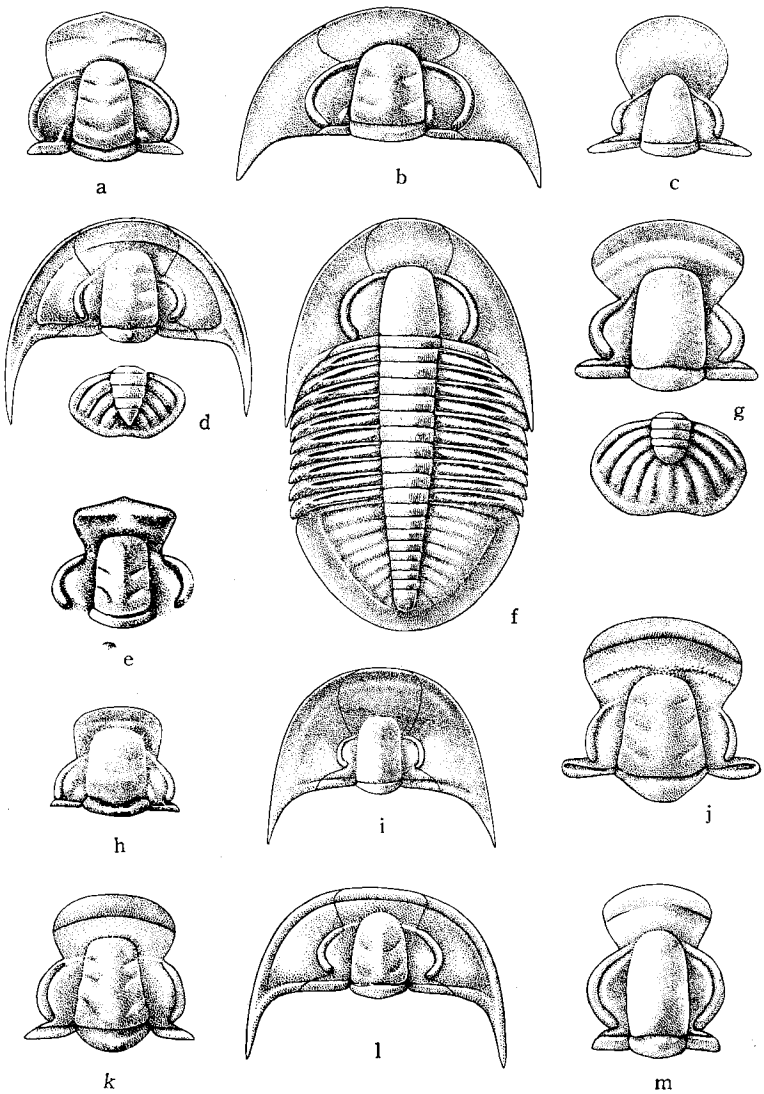
A broad pygidium with a narrow axial lobe and a broad depressed somewhat concave border looks similar to that of *Coosia* and *Paracoosia*. This pygidium is not segmented but distinctly segmented in *Paracoosia deprati* (MANSUY). Its outline is more allied to that of *Coosia superba* WALCOTT than to that of *P. deprati*. Its anterior margin is so strongly arcuate that the pygidium becomes broadest at the mid-length.

Occurrence:—*Eochuangia* zone at loc. 273.

Family Anomocaridae POULSEN, 1926

The rectangular or subquadrate glabella, large palpebral lobes and broad concave or depressed marginal border on the pygidium are most important chraracteristics of this family. POULSEN erected this family to include *Anomocare* and *Glyphaspis* which are isopygous ptychoparioids having fewer thoracic segments and larger palpebral lobes than in the Ptychopariidae. The Anomocaridae are said "especially characterized by the wide strongly concave rim of the head shield and the wide, strongly furrowed pygidium which has a broad concave border."

This family was, however, later understood more comprehensively by KOBAYASHI, (1935), HUPÉ (1955), HOWELL (1959), and BALASHOVA, IVSHIN and TCHERNYSHEVA (1960). At the same time its boundaries with the Asaphiscidae and Conokephalinidae became obscure. The glabella is more conical and palpebral lobe smaller in the typical Asaphiscidae, while the Conokephalinidae bear more ptychoparioid aspects on the cephalon and pygidium and more numerous segments in the thorax. Here the following genera are tentatively


a
b
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referred to this family.

Anomocaraspis IVSHIN, 1935. (*Anomocare hundwarense* REED)
Anomocare ANGELIN, 1854. (*Proetus laeve* ANGELIN)
Anomocarina LERMONTOVA, 1940. (*Proetus excavatum* ANGELIN)
Anomocarioides LERMONTOVA, 1940. (*Proetus limbatum* ANGELIN)
Anomocaropsis SIVOV, 1955. (*Anomocaropsis salairensis* SIVOV)
Caulaspis ROSOVA, 1960. (*Caulaspis angustus* ROSOVA)
Chondranomocare POLETAYEVA, 1956. (*Chondranomocare bidjensis* POLETAYEVA)
Eymekops RESSER and ENDO, in KOBAYASHI, 1935. (*Anomocarella hermias* WALCOTT)
Forchhammeria LERMONTOVA and TCHERNYSHEVA, 1950. (*Forchhammeria elegans* LERMONTOVA and TCHERNYSHEVA)
Glyphanellus IVSHIN, 1953. (*Glyphaspellus* (*Glyphanellus*) *margoritus* IVSHIN)
Glyphaspellus IVSHIN, 1953. (*Glyphaspellus primus* IVSHIN, Fig. 12j)
Glyphaspis POULSEN, 1927. (*Asaphiscus*? *capella* WALCOTT)
Hanivella SIVOV, 1955. (*Hanivella primaeva* SIVOV)
Haniwa KOBAYASHI, 1933. (*Haniwa sosanensis* KOBAYASHI)
Haniwoides KOBAYASHI, 1935. (*Haniwoides longus* KOBAYASHI)
Kotuia KOBAYASHI, 1943. (*Kotuia anomocaroides* KOBAYASHI)
Macrotoxus LORENZ, 1906. (*Anomocare angelini* GRÖNWALL)
Metanomocare LERMONTOVA, 1940. (*Metanomocare petaloides* LERMONTOVA)
Pseudanomocarina TCHERNYSHEVA, 1956. (*Pseudanomocarina plana* TCHERNYSHEVA)
Saimachia KOBAYASHI, 1937. (*Anomocare latelimbatum* DAMES)

Anomocare, *Anomocarina* and *Anomocarioides*, all from the *Solenopleura brachymetops* zone of Scandinavia agree with one another in the configuration of the glabella and palpebral lobes, but they differ principally in the preglabellar area and the pygidium. The area is clearly differentiated into the frontal limb and rim in *Anomocare*, but simple and concave or convex respecspectively in *Anomocarina* (Fig. 12b) and *Anomocarioides*. The marginal border of the pygidium is smooth, concave and well defined in *Anomocarioides*, (Fig.

Figure 12. Anomocaridae and allied genera.

a. *Forchhammeria elegans* LERMONTOVA
b. *Anomocarina excavata* (ANGELIN)
c. *Metanomocare petaloides* LERMONTOVA
d. *Pseudonomocare plana* TCHERYSHEVA
e. *Anomocaraspis hundwarensis* (REED)
f. *Anomocarioides limbataeformis* LERMONTOVA
g. *Chondranomocare bidjensis* POLETAYEVA
h. *Walcottaspidella suni* CHU
i. *Haniwoides longus* KOBAYASHI
j. *Glyphaspellus primus* IVSHIN
k. *Saimachia damesi* KOBAYASHI
l. *Eymekops hermias* (WALCOTT)
m. *Catuniella digna* JEGOROVA

12f), while the pleural furrows and ribs run into the border and the doublure is very wide in *Anomocarina* and also in *Anomocare*.

Macrotoxus from the *Paradoxides davidis* zone is allied to *Anomocare* but has a greater preglabellar area and shagreened text. RESSER (1937) has once erraneously synonymized *Macrotoxus* with *Conaspis* HALL, 1863. Except *Macrotoxus*, the above genera are well represented in Siberia, where *Metanomocare*, *Forchhammeria*, *Anomocaropsis* and some other endemic genera of the family occur.

Kotuia is closely allied to *Anomocare*, but it has the border of the pygidium narrow and convex. *Forchhammeria* (Fig. 12a) is another ally to *Anomocare* having the conical glabella and large palpebral lobes. Its preglabellar area is simply concave and distinctly pointed at the middle of the frontal margin. The glabella is slender and rather rapidly tapering, the palpebral lobe relatively small and the preglabellar field largely expanded in *Metanomocare* (Fig. 12c). As its reference to the Anomocaridae was doubted by WESTERGÅRD (1950), it is not quite diagnostic of the family.

Pseudanomocare (Fig. 12d) and *Chondranomocare* (Fig. 12g) are similar in some aspects of the cephalon and pygidium with each other. Their palpebral lobes are intermediate in size between *Anomocare* and *Anomocarella*. The glabella is more rounded in front and its lateral furrows are less obsolete in *Pseudanomocare* than *Chondranomocare*. Their pygidia are comparatively small, pleural lobes divided into strong ribs by deep pleural furrows, marginal rims narrow and the posterior margins sinuated. The axial lobe is cylindrical and very short in *Chondranomocare*.

Anomocare and *Anomocarioides* are known from Kazakstan; *Glyphaspellus* and its subgenus, *Glyphanellus*, are there indigenous. It is, however, remakable that *Glyphanellus* is intimate to *Saimachia*, a row of tubercles on the frontal limb being the most distinctive characteristic of *Glyphaspellus* not seen in other genera of the Anomocaridae.

Returning to Siberia, *Anomocariopsis* is represented by *Anomocariopsis salairensis* from the early Upper Cambrian of Salair which bears the rectangular glabella, large palpebral lobe, anteriorly expanded preglabellar area and its bipartation, all characteristic of the Anomocaridae. The anterior margin is usually transversal and mesially pointed as in *Forchhammeria*. Behind it there is seemingly a peculiar median ridge.

Of late Upper Cambrian *Hanivella* it is noted by SIVOV that his genus is more or less similar to *Haniwa* in the almost rectangular glabella and long eyes, but *Haniwa* has two pairs of furrows on the glabella, very broad fixed cheek, convex preglabellar field and a median tubercle on the neck ring. A further confirmation is required for its alliance to the Anomocaridae.

Distribution:—Middle and Upper Cambrian; Eurasia and Australia.

Genus *Anomocare* ANGELIN, 1854

1854. *Anomocare* ANGELIN, *Pal. Scand., Pt. 1*, p. 24.

1885. *Anomocare* ZITTEL, *Handb. d. Pal. Bd. 2*, S. 601
1902. *Anomocare* GRÖNWALL, *Danm. geol. Undersøk. Ser. 2, No. 13*, p. 140.
1910. *Anomocare* REED, *Pal. Indica, Ser. 15, Vol. 7, Mem. No. 1*, p. 44.
1911. *Anomocare* WALCOTT, *Smithson. Misc. Coll. Vol. 57, No. 4*, p. 87.
1913. *Anomocare* WALCOTT, *Research in China, Vol. 3*, p. 187.
1924. *Anomocare* ZITTEL-BROILI, *Grundzüge der Pal.* S. 648.
1930. *Anomocare* HOLM and WESTERGÅRD, *Mém. de l'Akad. des Sci. de l'U. R. S. S. Cl. Phys.-Math. Vol. 21, No. 8*, p. 17.
1935. *Anomocare* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 152.
1937. *Anomocare* HOWELL, *Bull. Geol. Soc. Am. Vol. 48*, p. 1193.
1940. *Anomocare* LERMONTOVA, *Atras of the Leading Forms of the Fossil Faunas of U. S. S. R. Vol. 1, Cambrian*, p. 154.
1950. *Anomocare* WESTERGÅRD, *Sver. Geol. Unders. Ser. C, Nio. 511*, p. 14.
1953. *Anomocare* IVSHIN, *Middle Cambrian Trilobites from Kazakstan.* p. 112.
1955. *Anomocare* HUPÉ, *Ann. de Pal. Tom. 41*, p. 189.
1959. *Anomocare* HOWELL, *Treatise on Invert. Pal. Pt. 0-1*, p. 286.
1960. *Anomocare* BALASHOVA, IVSHIN and TCHERNYSHEVA, *Principles of Pal. 8*, p. 91.

Type-species:—*Proetus laevis* ANGELIN, 1851.

Remarks:—Some 70 species of *Anomocare* have been described by ANGELIN (1954), BRÖGGER (1878), DAMES (1883), SCHMIDT (1886), WALCOTT; (1887, 1905, 06, 11), MENEGHINI (1888), GRÖNWALL (1902), WELLER (1903), LORENZ (1906), COBBOLD (1910), REED (1910, 34), MANSUY (1916), RICHTER (1919), RAYMOND (1922), LINDSTRÖM (1923), KING (1923, 30), HOLM and WESTERGARD (1930), HOWELL (1937), WHITEHOUSE (1939), LERMONTOVA (1940), SIVOV (1940), IVSHIN (1953) and JEGOROVA (1955). IVSHIN has elaborated a critical review of these species and proposed *Anomocaraspis* with *Anomocare hunduarensis* as its type-species. Here his synopsis is emended and supplemented.

Specific name of *Anomocare*	Present determination
aculeatus ANGELIN, 1851, *Proetus* (?)	*Agraulos* (*Proampyx*) *difformis* var.
acuminatus ANGELIN, 1851, *Proetus* (?)	*Agraulos* (*Proampyx*) *difformis* var. FRECH, 1897, (type)
alcinoe WALCOTT, 1905, *Anomocare*	*Anomocarella* (*Entorachis*) KOBAYASHI, 1955, (type)
angelini GRÖNWALL, 1902, *Anomocare*	*Macrotoxus* LORENZ, 1906, (type)
angustum WHITEHOUSE, 1939, *Anomocare* (?)	*Inouyella* (?)
arenivagum MENEGHINI, 1888, *Anomocare*	*Anomocarioides* (?) (IVSHIN, 1953)
balticum HEDSTRÖM, 1923, *Anomocare*	early meraspid of *Paradoxides*
batchatiensis SIVOV, 1940, *Anomocare*	*Anomocare salairensis*
bergeroni WALCOTT, 1905, *Anomocare*	*Changshanocephalus*
bianos WALCOTT, 1905, *Anomocare*	*Quadraticephalus*
bigsbyi WALCOTT, *Anomocare*	*Anomocarella*

(*Manchuriella* ?)
biston WALCOTT, 1905, *Anomocare* ..... *Metanomocarella*
butes WALCOTT, 1906, *Anomocare* (?) ..... *Anomocarella* (*Entorachis*) *subquadrata*
cobboldi RICHTER, 1919, *Anomocare* ..... *Strenuella* (*Comluella*) *platycephala*
commune LORENZ, 1906, *Anomocare* ..... *Anomocarella chinensis*
campbelli KING, 1923, *Anomocare* ..... *Kingaspis* KOBAYASHI, 1935, (type)
confertum WHITEHOUSE, 1939, *Anomocare* ..... *Schoriella* (?)
convexa WALCOTT, 1911, *Anomocare* ..... *Amecephalina* (RESSER, 1936)
conjuctiva REED, 1910, *Anomocare* ..... *Anomocarella* (?)
daulis WALCOTT, 1905, *Anomocare* (?) ..... *Monkaspis* KOBAYASHI, 1935, (type)
daunus WALCOTT, 1905, *Anomocare* ..... *Poshania*
decelus WALCOTT, 1905, *Anomocare* ..... ?
difformis ANGELIN, 1851, *Proetus* (?) ..... *Agraulos*
dikellocephaloides KING, 1930, *Anomocare* ..... *Pterocephalia*
dimotum REED, 1934, *Anomocare* ..... *Anomocaraspis* (?)
dubium HOWELL, 1937, *Anomocare* ..... Free cheek, indt.
ephori WALCOTT, 1911, *Anomocare* ..... *Proasaphiscus*
eriopia WALCOTT, 1906, *Anomocare* ..... Comp. "*Wentsuia*" and "*Parachangshania*"
excavatus ANGELIN, 1851, *Proetus* (?) ..... *Anomocarina* LERMONTOVA, 1940, (type)
extornatum HOLM and WESTERGÅRD, 1930, *Anomocare* ..... *Anomocarina*
flava WALCOTT, by SUN, 1924, *Anomocare* ..... *Luia suni* (RESSER), 1942
flava WALCOTT, 1906, *Anomocare* ..... *Anomocarella* (*Szeaspis*)
gravis JEGOROVA, 1955, *Anomocare* (?) ..... *Anomocare* (?)
hundwarensis REED, 1934, *Anomocare* ..... *Koptura*
latelimbatum DAMES, 1883, *Anomocare* ..... *Lioparia* LORENZ, 1906, (type); *Saimachia damesi* KOBAYASHI, 1937, (type-species)
latelimbatum DAMES, by WALCOTT, 1913, *Anomocare* .. *Lioparella walcotti* KOBAYASHI, 1937, (type)
cfr. *latelimbatum* DAMES, by MANSUY, 1916, *Anomocare* ..... *Eymekops*
latelimbatum DAMES by KING, 1930, *Anomocare* .... (?) (no illustration)
lermontovae IVSHIN, 1953, *Anomocare* ..... *Anomocare*
limbatus ANGELIN, 1851, *Proetus* (?) ..... *Anomocarioides* LERMONTOVA, 1940, (type)

lisani WALCOTT, 1911, *Anomocare* ..... *Koptura* RESSER and ENDO in KOBAYASHI, 1935, (type)
longifrons WESTERGÅRD, 1950, *Anomocare* ..... *Anomocare*
magnum BRÖGGER, 1878, *Anomocare* ..... *Anomocarioides* (?)
majus DAMES, 1883, *Anomocare* ..... *Anomocarella*
megalurus (DAMES) by WALCOTT, 1913, *Anomocare*.. *Anomocarella* (*Manchuriella*) *distincta* RESSER and ENDO, 1937; *Grandioculus shansiensis* (RESSER), 1942
megalurus (DAMES), by KING, 1930, *Anomocare*..... Protolenid
cfr. *megalurus* (DAMES) by, MANSUY, 1900, *Anomocare* ..... *Kainella primigena* KOBAYASHI, 1953
microphthalmus ANGELIN, 1851, *Proetus* (?)..... *Grönwallia*
minus DAMES, 1883, *Anomocare* ..... *Anomocarella* (*Manchuriella*)
minus DAMES by WALCOTT, 1913, *Anomocare* ..... *Anomocarella* (*Manchuriella*) *typa* RESSER and ENDO, 1937, (type-sp.)
minus var. by WALCOTT, 1913, *Anomocare*..... *Anomocarella* (*Manchuriella*) *tapingensis* RESSER and ENDO, 1937
minus DAMES by MANSUY, 1916, *Anomocare* ..... *Hundwarella*
nanum DAMES, 1883, *Anomocare*..... *Metagraulos*
nereis WALCOTT, 1906, *Anomocare*..... *Metanomocarella*
novatum REED, 1934, *Anomocare*..... *Anomocaraspis* (?)
ovatum LORENZ, 1906, *Anomocare* ..... *Anomocarella temenus*
parvula WELLER, 1903, *Anomocare* ..... *Bowmania* (HOWELL, 1945)
pawlowskii SCHMIDT, 1886, *Anomocare* ..... *Tollaspis* KOBAYASHI, 1943, (type)
parvum COBBOLD, 1910, non WALCOTT, 1884, *Anomocare* ..... *Strenuella* (*Comluella*) *cobboldi* (RICHTER)
parvum WALCOTT, 1884, *Anomocare* (?) ..... *Onchocephalus* (RESSER, 1937)
perfunctum REED, 1934, *Anomocare* (?)..... *Anomocaraspis* (?)
persicum KING, 1930, *Anomocare*..... "*Taishania*"
planum DAMES, 1883, *Anomocare* ..... *Anomocarella*
platycephalum COBBOLD, 1910, *Anomocare*..... *Strenuella* (*Comluella*) HUPÉ, 1952, (type)
pusillum MENEGHINI, 1884, *Anomocare* ..... *Anomocarina* (?), (IVSHIN, 1953)
pustulatum COBBOLD, 1910, *Anomocare* ..... *Strenuella*
propinquum MANSUY, 1916, *Anomocare*..... *Lioparella*
rex HOWELL, 1937, *Anomocare* (?) ..... Thoracic pleuron, indt.

salairensis LERMONTOVA, 1940, *Anomocare* ..... *Anomocare*
sibiricum HOLM and WESTERGÅRD, 1930,
Anomocare ..... *Anomocarina*
speciosum LORENZ, 1906, *Anomocare* ..... *Anomocarella*
stenotoides MATTHEW, 1898, *Anomocare* ..... aff. *Acantolenus spiniger* MATTHEW, 1898
subcostatum DAMES, 1883, *Anomocare* ..... *Anomocarella*
subquadratum (DAMES) by WALCOTT, 1913,
Anomocare ..... *Anomocarella* (*Entorachis*)
subquadratum (DAMES) by MANSUY, 1916,
Anomocare ..... *Anomocarella* (*Manchuriella*)
cfr. *subquadratum* (DAMES) by MANSUY, 1915,
Anomocare ..... Saukid
subquadratum (DAMES) by KING, 1930, *Anomocare*.. *Maladioides* sp. nov.
suspectum REED, 1934, *Anomocare* ..... *Anomocaraspis* (?)
tatian WALCOTT, 1905, *Anomocare* ..... *Anomocarella*
temenus WALCOTT, 1905, *Anomocare* ..... *Anomocarella*
vermontensis HOWELL, 1937, *Anomocare* ..... Free cheeks and pygidium, indt.
vittata RAYMOND, 1922, *Anomocare* ..... pygidium, gen. indt.

Beside the above listed, DAMES (1883) referred the following three species to *Anomocare*:

Conocephalites hamulus HALL, 1863
Conocephatites wisconsiensis HALL, 1863 (=*Lonchocephalus hamulus* OWEN, 1852)
Conocephalites patersoni HALL, 1863

The first and second species were placed in *Saratogia* by WALCOTT (1916) and in *Idahoia* by RESSER (1935) and the third was made the type-species of *Psalaspis* by RESSER (1937).

Anomocare balticum is based on an immature cranidium, 3 mm. long, which shows good agreement with early meraspids of *Paradoxides* illustrated by WESTERGÅRD (1936) from Oeland. It is quite probable that the Comley species of *Anomocare* belong to *Strenuella*. *Anomocare platycephalum* for which HUPÉ has proposed *Comluella* differs from *Strenuella* simply in the absence of the nuchal spine. *A. campbelli* KING is the type-species of *Kingaspis*. As pointed out elsewhere (1961), his *Anomocare megalurus* was found together with *Redlichia* in a limestone of Kuhbanan, Iran, and has the morphic significances enough to be referred to a protolenid, although it is difficult to answer its proper generic position.

A. stenotoides is quite distinct from *Anomocare*, but certainly intimate to *Acantolenus spiniger* MATTHEW, particularly in the possession of the so-called apical spine by MATTHEW.

Because *Anomocare subquadratum* and *A. persicum* are accompanied by *Chuangia nais* and *Billingsella tonkiniana* in a limestone of Kuh-i-Namuk, Iran, their age must be Changshanian. Judging from the illustration the so-called

subquadratum best fits in *Maladioides* in the stout glabella, oblique lateral furrows, size and position of the palpebral lobes and convex frontal limb and rim. The relative length between the limb and rim is the chief distinction of this species from *M. asicticus* and *M. fragmentus*. *A. persicum* more or less resembles *Taishania*, but probably it represents a new genus by itself. In view of the short glabella, large palpebral lobes, broad brim of the cranidium and the outline and other aspects of the associated pygidium, I would suggest *Pterocephalia* for *Anomocare dikellocephaloides* KING from Darreh Duzdam, Iran.

Lioparia latelimbatum, *Changshanocephalus bergeroni* and *Quadraticephalus bianos* are all Upper Cambrian trilobites. *Anomocare eriopia* looks more similar to *Wentsuia* than any other genus, but it is a Changhian trilobite.

A. cfr. *megalurus* by MANSUY for which I have erected *Kainella primigena* indicates that the uppermost fossil zone of the Changpoung series on the Yunnan-Tonkin border attains the Lower Ordovician.

It is astonishing that the cranidium of *Anomocare confertum* reveals several features common with *Schoriella* or even with *Lakella* or British species of *Conokephalina*, i.e. *C. invita* (SALTER), *C. abdita* (SALTER) and *C. lata* LAKE. *A* (?) *angustum* on the contrary, appears to have a distinct crescentic depression in front of the glabella. This biocharacter combined with the conical glabella and relatively broad fixed cheeks is quite suggestive of *Inouyella* for its generic position.

As noted by REED in the postscript, *Anomocare conjunctiva* in a limestone block on the Parahio valley, Spiti, may be allied to *Anomocarella*. Three pairs of strong pits on the glabella and a row of median tubercles on the pygidium are, however, biocharacters which no Eastern Asiatic species of *Anomocarella* bears. *Anomocare* sp. from the same locality belongs probably to *Eymekops*, and *Agnostus spitiensis* to *Peronopsis* (KOBAYASHI, 1939).

Anomocare hundwarensis from Kashmir which is the type-species of *Anomocaraspis* is represented by a nearly complete dorsal shield with 9 segments in thorax. As it was once referred to *Eymekops* (1944), it has a subcylindrical glabella like *E. hermias* and its pygidium is triangular, multisegmented and provided with a narrow marginal border like that of *E. macar*. The preglabellar field is, however, considerably larger than those of *hermias* and *macar*. It is longer and much wider than the preglabellar field of "*Anomocare*" *ephori* which differs from *A. hundwarensis* in the abrupt tapering of the glabella and rounded outline of the pygidium.

Anomocare dimotum, *A. novum*, *A. suspectum* and *A. perfunctum* are all represented only by cranidia whose frontal limbs are much shorter than that of *A. hundwarensis*. Because they are badly deformed, they can be congeneric with *Hundwarella personata*.

In Eastern Asia there are some 25 species which have originally been designated as *Anomocare* by DAMES, LORENZ and WALCOTT, beside several which have once been transferred into *Anomocare* by WALCOTT. Through the repeated revisions, however, they have been brought into some other

genera by WALCOTT, KOBAYASHI, RESSER and ENDO. After all none is left in *Anomocare*. WESTERGÅRD (1950) mentioned that "a few of these Asiatic forms, e. g. *Anomocare ephori* WALCOTT which RESSER and ENDO placed in their genus *Proasaphiscus*, seem to be so similar to *A. laevis* that, if found in Scandinavia, they would be referred to *Anomocare*". The glabella of *ephori* is, however, much shorter, and relatively smaller than that of *A. laevis*, *A. longifrons*, *A. lermontovae* or *A. salairensis*.

Distribution:—Late Middle Cambrian; Scandinavia, Siberia and Central Asia.

Genus *Saimachia* KOBAYASHI, 1937

1937. *Saimachia* KOBAYASHI, *Jour. Geol. Soc. Japan, Vol. 44*, p. 430.
1959. *Saimachia* HOWELL, *Treatise on Invert. Pal. O-1*, p. 288.

Type-species:—*Saimachia damesi* KOBAYASHI, 1937, (Fig. 12k).

This genus is well characterized by the fairly large truncato-conical glabella, rapidly tapering forward, three pairs of oblique lateral furrows of moderate strength, very large palpebral lobes with distinct eye-ridges, fixed cheeks half as wide as the glabella, raised frontal rim and depressed frontal limb which are subequal in size; facial sutures anterior to eyes semicircular.

This genus differs from *Anomocarella* and its allies in the size of the palpebral lobes and also by the rapidly tapering glabella. The lobes are, however, not so large as in *Eymekops*. The course of the anterior facial suture is also different between *Saimachia* and *Eymekops*. *Ptychoparia* (?) *maia* WALCOTT, 1906, and *Eymekops granulosa* ENDO, 1944, may be referable to this genus.

Distribution:—Middle (?) and early Upper Cambrian of Eastern Asia.

Genus *Eymekops* RESSER and ENDO in KOBAYASHI, 1935

Type-species:—*Anomocarella hermias* WALCOTT, 1911, (Fig. 12l).

The thorax is composed of 13 segments in *Conokephalina sinansis* MANSUY, 1916, which belongs to *Eymekops* (KOBAYASHI, 1942).

PA4122-1-5
PA4123-1-6

Eymekops perlongatus KOBAYASHI, new species

Plate I, Figures 5-6.

This is diagnostic of *Eymekops* as revealed by its long subquadrate glabella, blunt median keel, narrow neck ring with a median tubercle, very large palpebral lobe protruded postero-laterally and the gradually expanded flat frontal limb as indicated by weak divergence of anterior facial sutures. The glabella is, however, unusually long and its length just corresponds to twice its breadth. Combined with the eye-ridge, the eye-band describes a half of an ovoid which is most expanded in posterior. In the anterior half the band runs nearly straight and oblique. The frontal limb is fairly long and the cranidium itself is relatively long for the genus.

The associated pygidium is triangular and bordered by a flat depressed

rim of moderate breadth. Furrows on axial and pleural lobes are all weak.

Occurrence:—*Tonkinella* zone at loc. 109.

Eymekops mesops KOBAYASHI, new species

Plate V, Figure 13.

PA4/24

Description:—Cephalon exclusive of genal spines semi-circular; glabella comparatively large and palpebral lobes relatively small for genus. The glabella subcylindrical, convex, about four-fifths as long as cranidium, slightly tapering forward, and well rounded in front; no lateral furrows; short neck ring separated from main part of glabella by a deep furrow; palpebral lobe semicircular, a third as long as cranidium, directly attached to glabella; frontal limb and rim nearly equal in length, the former flat and depressed whereas the latter is a little elevated; free cheek provided with a short genal spine; anterior facial sutures slightly divergent from eyes and diagonal on frontal rim for some distance; posterior suture transversal and turning back near the lateral end; test smooth.

Occurrence:—Black shale at loc. 313.

Genus *Anomocaraspis* IVSHIN, 1953

1953. *Anomocaraspis* IVSHIN, *Middle Cambrian Trilobites from Kazakstan, 1*, p. 125.

Type-species:—*Anomocare hundwarense* REED, 1934, (Fig. 12e).

Remarks:—As the type-species has been referred to *Eymekops*, this genus is most closely related to *Eymekops* as recognizable in many aspects, but the glabellar furrows are usually distinct not only in the type-species, but also in

Anomocare dimotum REED,

Anomocare novatum REED,

Anomocare (?) *perfunctum* REED, and

Anomocare suspectum REED

which were all included in *Anomocaraspis* by IVSHIN. The thorax consists of 9 segments and the pygidium is fairly large and triangular in the type-species.

Distribution:—Middle Cambrian; Kashmir.

Genus *Haniwoides* KOBAYASHI, 1935

1935. *Haniwoides* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 242.

1955. *Haniwoides* HUPÉ, *Ann. de Pal. Tom. 41*, p. 189.

1959. *Haniwoides* HOWELL, *Treatise on Invert. Pal. 0-1*, p. 288.

Type-species:—*Haniwoides longus* KOBAYASHI, 1955, (Fig. 12i).

This genus is similar to *Eymekops*, but can be distinguished from that genus by the long concave preglabellar field and relatively small, semi-circular palpebral lobes which are located close to the posterior of the glabella. The glabellar outline is oblong and its lateral furrows are obscure. In *Haniwoides concavus* the anterior sutures join with each other in front to form a median

suture. The associated pygidium is broad, semicircular and surrounded by a broad marginal border.

Distribution:—Late Middle Cambrian; Eastern Asia.

Haniwoides longissimus KOBAYASHI, new species

PA4041

Plate II, Figure 7.

This is represented by a cranidium closely allied to *Haniwoides longus*. It is 5.7 mm. long; glabella 4.3 mm. long and 2.2 mm. broad, parallel-sided, slightly expanded at neck, well rounded in front, axially keeled, measuring 2.5 mm. in length; lateral furrows obscure; preglabellar area slightly concave; anterior margin well arcuate.

Occurrence:—*Eochuangia* zone at loc. 262.

Haniwoides tenuis KOBAYASHI, new species

PA4125

Plate II, Figures 8–9.

This species is a close ally to *Haniwoides concavus* from which it differs in the more slender glabella, its well rounded anterior and occipital margin, smaller palpebral lobes, connected with the glabella by very oblique ridges through narrow fixed cheeks and forwardly expanded preglabellar area which is remarkably bent up along the frontal periphery. In *H. concavus* the glabella is relatively large and subquadrate, eyes are very large, set close to the glabella and the preglabellar field is much narrower.

Occurrence:—*Eochuangia* zone at loc. 274.

PA4126-2-18
PA4127-2-19
PA4128-3-18
PA4129-3-19
PA4130-3-20
PA4131-3-21
PA4132-3-22

Haniwoides (?) *puteolatus* KOBAYASHI, new species

Plate II, Figures 18–19; Plate III, Figures 18–22.

This species seems to be intimate to *H. tenuis*, but has a more quadrate glabella, three pairs of glabellar pits, middle and posterior ones of which are especially pronounced, and a deep occipital furrow. In the presence of the pits it is unlike *Haniwoides*, but it looks very much like *Parabriscoia* (?) *tripunctata* KOBAYASHI, 1935, although the palpebral lobe is larger in this species.

An imperfect pygidium having a narrow axial lobe and double furrows on the pleural lobe which extend into the broad concave marginal border was procured from the same locality (262) with three cranidia of this species.

The pygidium from loc. 225 gives a better concept. Its length and breadth are in proportion of about 2 to 3. The axial lobe occupies one-fifth of the pygidium in breadth. In still another pygidium from Neietsu the pleural lobe is seen to be seven-segmented, each being composed of a broad anterior and a narrow posterior ridge. The pygidium resembles the imperfect pygidium referred to "*Pterocephalia*" *asiatica* WALCOTT, 1913, in the general

aspect, but the pleura is a single rib in that pygidium. The cranidium of *asiatica* is quite different from this cranidium in the presence of a well expanded large brim.

In the double pleural ribs this pygidium resembles that of *Briscoia*, but its outline is much longer and lacks the posterior sinuation. At all events this pygidium is quite different from the associated pygidium of *Haniwoides concavus*. It is very probable that this species respresents an undescribed genus.

Occurrence:—*Eochuangia* zone at locs. 225, 227, 261, 262 and Nei 1.

Genus *Walcottaspidella* CHU, 1959

1959. *Walcottaspidella* CHU, *Mem. Inst. Pal. Acad. Sinica, No. 2*, p. 76, 120.

Type-species:—*Walcottaspidella suni* CHU, 1959, (Fig. 12h).

CHU established this genus as a member of the Osceolinae. *W. suni* CHU is the monotypic species which agrees with the Anomocaridae no less than the Osceolinae. The median occipital tubercle and small basal side-lobes are present in *Anomocarina* and *Forchhammeria* and the tubercle in *Pseudanomocare* and *Saimachia*. The associated pygidium is also not strange for the Anomocaridae.

The postero-lateral part of the fixed cheek is unpreserved in the type specimen and accordingly the restoration of this part is imaginary. A further information is needed to decide its family reference.

Distribution:—Kushanian; Liaoning.

Family Tsinaniidae KOBAYASHI, 1933

A complete dorsal shield is known of *Koldiniella convexa* LAZARENKO, 1960, in which the thorax is composed of 10 segments and the genal spine appears absent on the cephalon. Its cranidium is similar in the essential biocharacters to that of *Esseigania tolli* KOBAYASHI, 1943, no less than that of *Koldiniella mitella* SIVOV, 1955.

Suborder Dikelocephalidina KOBAYASHI, 1935

Family Dikelocephalidae MILLER, 1889

Genus *Briscoia* WALCOTT, 1924

Briscoia (?) sp. indt.

Plate III, Figure 23.

PA4/33

An imcomplete pygidium similar to that of *Coosia* (?) sp. indt. in many features, but the anterior margin is more arcuate and the posterior margin more or less sinuated behind the axis; pleural lobe furrowed. The breadth of the pygidium becomes at the maximum at about one-third the length from posterior. The pleural rib is divided by a furrow into a broad anterior and

a narrow posterior one as seen in the pygidium of *Haniwoides puteolatus*. The pygidium of *Briscoia* is the nearest to this pygidium, but there is no cephalon to support this reference. The associated trilobites on the contrary show its older age.

Occurrence:—*Eochuangia* zone at loc. 293.

Suborder Asaphina SALTER, 1864

Family Ceratopygidae LINNARSSON, 1869

Subfamily Proceratopyginae KOBAYASHI, 1955

Ceratopygidae with conical or cylindrical glabella, 9 segments in thorax and a pair of anterior lateral spines on pygidium. Late Middle to Upper Cambrian and (?) Lower Ordovician; Scandinavia, Central Asia, China, Korea, Australia and (?) Argentina.

Proceratopyge WALLERIUS, 1895. (Type-species: *Proceratopyge conifrons* WALLERIUS) comprises three subgenera, namely, *Proceratopyge* s. str., *Kogenium* KOBAYASHI, 1935 (*Kogenium rotundum* KOBAYASHI) and *Lopnorites* TROEDSSON, 1937. (*Lopnorites rectispicatus* TROEDSSON).

Proceratopyge inexpectans HARRINGTON from the Tremadocian of La Rioja is represented by a pygidium which agrees with *Proceratopyge* as well as *Onychopyge*, if it is allowed to consider somewhat compressed in the axial direction. *Proceratopyge incodita* HARRINGTON and LEANZA from the Tremadocian of Salta is based on a cranidium which has a much larger glabella than *P. conifrons* and other Cambrian forms, in comparison with the cranidium.

Ceratopeltis POULSEN, 1937, (*C. latilimbatus* POULSEN) from Upper Canadian of East Greenland is based on the pygidia resembling those of the Ceratopyginae, but its true relationship is a question. *Dipleuropyge* LERM. 1951 (*D. striata* LERM.) from the Upper Cambrian of Kazakstan was first referred to this family and later to the Damesellidae (TCHERNYSHEVA et al. 1960), but it does not quite agree with either one of the two families. It is somewhat similar also to *Mexicaspis*. A better material is needed to advance a further discussion.

Finally, the Housiinae HUPÉ, 1953, including *Housia* and *Housiella* (1955) are intermediate in some characters between the Marjumiidae and Ceratopygidae. It is also suggested that the family is allied to the Pterocephalidae.

Genus *Proceratopyge* WALLERIUS, 1895

Proceratopyge (*Proceratopyge*) sp. indt.

Plate V, Figure 2.

PA4134

1935. Comp. *Kogenium triangulare* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 275, pl. 17, fig. 4, only.

This cranidium is closely allied to that of *Proceratopyge nathorsti* WESTERGÅRD, except the shortness of the glabella. It is ovoid, strongly convex, a

little longer than broad, rounded in front, carrying a median tubercle in posterior, and unfurrowed except an occipital furrow. Compared to *P. nathorsti*, eyes are somewhat larger and the cranidium is broader. Like that species, the frontal border is upturned and the facial suture appears intramarginal. If the broad pygidium of *Kogenium triangulare* goes with this broad cranidium, a greater similarity is found between this and *P. nathorsti* (fig. 2, pl. 2, WESTERGARD, 1947). The axial lobe of the pygidium is, however, decidedly narrower in *K. triangulare*.

Occurrence:—*Eochuangia* zone at loc. 274.

Subgenus *Kogenium* KOBAYASHI, 1935

1935. *Kogenium* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 273.
1953. *Kogenium* HUPÉ, *Ann. de Pal. Tom. 39*, p. 161.
1959. *Kogenium* POULSEN, *Treatise on Invert. Pal. 0-1*, p. 363.

When I have instituted *Kogenium* as a genus, I thought it more allied to *Kaolishania* than *Hysterolenus*. At that time the Ceratopygidae were unrepresented in Eastern Asia, but now the family is well represented in Liaoning, South Korea, Central China, Eastern Tienshan and further in Australia. Recently I have carried out a revision of the family with ICHIKAWA (1955). As the result I reached the conclusion that *Kogenium* and *Lopnorites* are two subgenera of *Proceratopyge*. The pygidium is very broad in *P. conifrons* and quite long in *Kogenium rotundum*, *Lopnorites rectispicatus* taking an intermediate position between the two.

Kogenium rotundum was founded on the pygidium. The cranidium previously referred to the species had a conical glabella with three pairs of oblique lateral furrows. It bears many similarities to that of *Kaolishania*. This combination of detached carapaces was again carefully examined with a large collection. As the result it became more probable for *Kogenium* to have an asaphoid cranidium. As described below, its eyes are of moderate size and set close to the glabella. The anterior facial suture is intramarginal and joins its counter at the median point of the frontal margin. This cranidium reveals closer relationship to *Proceratopyge* s. str. than *Lopnorites*, but more advanced than these two allies.

A forked hypostoma is contained together with a cranidium of *Haniwoides puteolatus* in a sample from loc. 262, but it is not the less probable for it to belong to the megalspoid cephalon which also occurs at this locality.

It is a great interest to find a larval cranidium which resmbles the meraspid of *P. conifrons* in fig. 7 (WESTERGARD, 1948), although its glabella is more cylindrical than in *P. conifrons*. A polysegmented pygidium from loc. 257 and trisegmented one from loc. 258 are not much different from those of *P. conifrons* in fig. 14 and fig. 15 (WESTERGARD, 1948) respectively. The agreement of immature carapaces is a further confirmation for the intimate relationship between *Kogenium* and *Proceratopyge*.

PA4135-4-5
PA4136-4-6
PA4137-4-7
PA4138-4-8
PA4138-4-9
PA4139-4-10
PA4140-4-11
PA4141-4-12
PA4142-4-13
PA4143-4-14
PA4144-4-15
PA4145-4-16
PA4146-4-17
PA4[illegible]
PA4036-7-15
PA4117-8-25
PA4147-9-292

Distribution:—This subgenus is well represented in *Eochuangia* limestone and shale, but not found in the limestone containing *Olenoides*.

Proceratopyge (*Kogenium*) *rotundum* KOBAYASHI, 1935

Plate IV, Figures 5-17; Plate VII, Figure 15; Plate VIII, Figure 25; Plate IX, Figure 20-21.

1935. *Kogenium rotundum* KOBAYASHI, *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 4, Pt. 2*, p. 274, pl. 17, figs. 6-9.

The cranidium referred here to this species is moderately convex, elevated above flat cheeks, subcylindrical, slightly tapering forward and rounded off in front; lateral furrows obscure, but posterior two pairs are discernible by cross light; occipital furrow obsolete; axial carination sometimes distinct; no median tubercle; eyes extending laterally from middle third of glabella; frontal limb narrow, fairly long and depressed; frontal border about half as long as the frontal limb and bent up; free cheek provided with a genal spine; facial sutures a little divergent from the sides of frontal lobe and abruptly recurving on marginal border and meet each other on axis; posterior suture nearly transversal behind eye and turning back near the genal spine.

The above cranidium bears several characters common with that of *Promegalaspis pelturae* WESTERGÅRD, 1939. In the latter, however, an occipital furrow and a median tubercle are present and the anterior facial sutures more widely divergent. Its associated hypostoma is also forked, but the posterior ridge is undeveloped and the outline not expanded laterally as in the hypostoma which is supposed to belong to this species.

In a specimen from loc. 93003 two free cheeks are apparently fused by the doublure. The pygidium from the same locality shows the doublure only a little broader than the marginal border of the dorsal shield.

The pygidium in fig. 25, pl. 18 has an unusually long spine on each side which is twice as long as the main pygidium. The posterior margin is well rounded between the spines.

A pygidium in fig. 15, pl. 17 is broader than the adult form, but may represent an immature stage of the same species.

Finally, *Proceratopyge rotunda* KRYSKOV, 1960, must be renamed because of its homonymy with the present species.

Occurrence:—*Eochuangia* zone at locs. 257, 258, 262, 273, 274, 281, 292, 301, 93003, Ita 7 and Nei 1; black shale from loc. 199.

Subgenus *Lopnorites* TROEDSSON, 1937

PA4148-6-11
PA4149-6-12

Proceratopyge (*Lopnorites*) *rectispicatus* TROEDSSON, 1937

Plate VI, Figures 11-12.

1937. *Lopnorites rectispicatus* TROEDSSON, *The Shino-Swedish Expedition, Publ. 4*, p. 35, pl. 2, figs. 1-2.

1955. *Proceratopyge* (*Lopnorites*) *rectispicatus* KOBAYASHI and ICHIKAWA, *Trans. Proc. Pal. Soc. Japan, N. S. No. 19*, p. 67, pl. 11, fig. 16.

The pygidium in fig. 11 is 10 mm. long and 17 mm. broad; its axial lobe 8.5 mm. long and 4 mm. broad; marginal border 2.3 mm. in breadth. This pygidium exclusive of spines subtriangular; anterior axial ring as wide as one-fifth the pygidium; axis conical, long and divided into about ten rings, the last of which being small and triangular and the pointed hind part of the axis extending beyond the inner margin of the border. The pleural lobe is divided into about six segments, the first one of which is produced back into a lateral spine; each pleural rib divided into two riblets by an interpleural furrow; marginal border flat; its inner margin indicated by a narrow groove except the anterolateral part where its pleural rib runs across the border and extends into the spine. Surface smooth.

The pygidium reveals no striking difference from that of the holotype of *Lopnorites rectispicatus*. Compared to *Lopnorites* sp. in fig. 18, on pl. 5, from HUNAN (1938), it is broader.

Another pygidium in fig. 12 looks more or less semicircular; axis consists of more than eight rings; pleural lobe of six segments; each pleuron distinctly divided into double riblets; doublure wide and widened posteriorly. Although the lateral spine is unpreserved, its close affinity can hardly be overlooked to this species.

Occurrence:—*Iwayaspis* zone; a boulder found at loc. 313.

PA4150-6-13
PA4151-9-23a
PA4152-9-23b
PA4153-9-22

Proceratopyge (*Lopnorites*?) *robustus* KOBAYASHI, new species

Plate VI, Figure 13, Plate IX, Figures 23, (?) 22.

This is represented by a pygidium which is relatively long and measures 18 mm. in length. Its maximum breadth lies at about one-third from anterior and estimated to be 25 mm., if the pygidium is complete. Its axial lobe is large, stout and consists of seven or more rings. The first axial ring is 7.5 mm. broad. The axial lobe exclusive of the post-axial ridge is 13 mm. in length. The lobe is abruptly pointed in posterior whence a postaxial ridge issues. The pleural lobe is divided into some four ribs. The pleural lobe is relatively narrow, gently slant outward and gradually transmits into the marginal border which is flat or even concave. The pleural ribs and furrows die out on the border. The first pleuron is fairly large and prolonged into a spine.

The hypostoma is ovate in outline, but a little alate in the anterior; a pair of small tubercles located behind the main body; marginal rim very narrow. They are tentatively placed here on account of their association with the pygidium.

Occurrence:—*Iwayaspis* zone at locs. 313 and (?) Ita 11.

Subfamily Ceratopyginae LINNARSSON, 1869

Ceratopygidae with subcylindrical glabella expanded in the middle, or dilate forward, 5 or 6 segments in thorax, and one or more pairs of lateral spines on pygidium. Upper Cambrian to Lower Ordovician: Scandinavia, Cent-

PA4153 cfr. P. (L.?) robustus Kobayashi, Pl. 9. f. 22 PA4153-9-22

ral Asia and Argentina.

Ceratopyge HAWLE and CORDA, 1847. (*Olenus forficula* MOBERG). Tremadocian; Scandinavia and Argentina.

Hysterolenus MOBERG, 1898. (*Hysterolenus tornquisti* MOBERG). Tremadocian; Scandinavia and Upper Cambrian of Kazakstan.

Diceratopyge TROEDSSON, 1937. (*Dicertopyge mobergi* TROEDSSON). Upper Cambrian of Tienshan.

Onychopyge HARRINGTON, 1938. (i.e. *Prionopyge* HARRINGTON and LEANZA, 1952.) (*Onychopyge riojana* HARRINGTON) Tremadocian; Argentina.

Dichelopyge HARRINGTON and LEANZA, 1952. (*D. pascuali* H & L.) Upper Cambrian of Tienshan.

Paraceratopyge POLETAYEVA, 1945. (*P. kousnezkiensis* POLETAYEVA). Tremadocian of Siberia.

Boschchekulia LERMONTOVA, 1951. (*B. lata* LERMONTOVA). Upper Cambrian of Kazakstan.

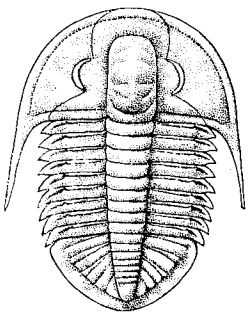

Figure 13. *Iwayaspis asaphoides* KOBAYASHI, n. gen. and sp.

Subfamily Iwayaspidinae KOBAYASHI, new subfamily

Ceratopygidae but lateral spines being absent or rudimentary on the pygidium.

From the morphological point of view *Pseudohysterolenus* HARRINGTON and LEANZA, 1952, (*P. infidus* H & L.) can be combined with *Iwayaspis* in the same subfamily. The geological and geographical isolation, however, requires any connecting link to confirm their phyletic intimacy.

Distribution:—Upper Cambrian of Eastern Asia and (?) Lower Ordovician of Argentina.

Genus *Iwayaspis* KOBAYASHI, new genus

Diagnosis:—Similar to *Proceratopyge*, but possesses no spine on pygidium.

Type-species:—*Iwayaspis asaphoides* KOBAYASHI, new species. (Fig. 13).

Remarks:—This is similar also to primitive asaphids, but has nine, instead of eight thoracic segments. What is known of this genus is mentioned in the description of the monotypic species.

PA4154-6-1,6
PA4155-6-2
PA4156-6-3
PA4002-6-4
PA4157-6-5
PA4158-6-7
PA4159-6-8
PA4160-6-9
PA4161-6-10
PA4004-8-24
PA4044-9-24

Distribution:—Early Upper Cambrian; Eastern Asia.

Iwayaspis asaphoides KOBAYASHI, new genus and species.

Plate VI, Figures 1-10, (?) Plate VIII, Figure 24, Plate IX, Figure 24.

Description:—Carapace long, elliptical; cranidium a little longer than thorax and about one and a half as long as pygidium, and provided with four pairs

of lateral furrows and an occipital furrow; anterior two furrows extended antero-laterally and posterior two furrows postero-axially from the lateral sides of glabella. Central area between anterior and posterior furrows large; occipital furrow describing a semicircle, convex backward; fixed cheek of moderate breadth; palpebral lobes of medium size, opposed at mid-length of cranidium, palpebral ridge running a little oblique forward from eye to the first lateral furrow; preglabellar area divided into a frontal limb and rim of subequal breadth by a shallow but relatively broad marginal furrow. Free cheek provided with a long genal spine; describing a semicircle in front of eyes, facial sutures join at median point of the border whence a sagittal suture crosses the doublure. Hypostoma oblong, more or less truncated in front; central body large, surrounded by a narrow rim; middle point on lateral side of hypostoma lying at juxta-position to the inner end of eye-band.

Thorax consists of nine segments; axial lobe gradually tapering back; axial ring wider than two-thirds of pleuron in the first segment, but in the ninth the ring almost half as wide as a pleuron; fulcrum prominent at about middle point on anterior pleural band; pleural furrow slightly oblique; pleural end pointed laterally in anterior segments, but bent back in posterior ones.

Pygidium almost twice as broad as long; axis somewhat more abruptly tapering back than thoracic axis and terminating at a blunt end; axis composed of six rings and a triangular terminal lobe; six pleurae countable on pleural lobe and each divided into two unequal ribs by an interpleural groove; marginal border depressed. Surface smooth.

Observation:—The holotype carapace 16 mm. long (fig. 1, pl. VI) is a complete dorsal shield except free cheeks. It is associated with the hypostoma in fig. 6 in the same piece of shale. The doublure of the free cheek in fig. 2 is truncated at the median suture. The relative position of the hypostoma to the eyes is shown on the imperfect carapace in fig. 5.

Comparison:—In the outline of the glabella and four pairs of lateral furrows this species agrees with *Hysterolenus* and *Proceratopyge*. It has nine segments in thorax as in *Lopnorites* and *Proceratopyge* (WESTERGÅRD, 1947, '48). The pleural ribs of its pygidium are each divided into double riblets by an interpleural furrow as in most genera of the Ceratopygidae. Aside from the absence of a pair of spines on the pygidium, its difference from the Ceratopygidae lies in the relatively large eye. Its hypostoma, compared to that of *Hysterolenus*, is broader and its marginal rim narrower. Nevertheless, its close relation to the ceratopygids is beyond doubt.

The facial suture is typical of the Asaphinae. In the outline of the glabella and the furrows on it this species is certainly different from the Ordovician Asaphidae, but it bears similarities to such Cambrian asaphids as *Eoasaphus* (1936), *Charchaqia* (TROEDSSON, 1937) and *Yüpingia* (LU, 1956). It is probable that the Asaphidae were derived from such a form by the reduction of a segment from the thorax. Likewise, the number of thoracic segments are reduced to 6 in *Ceratopyge* (REGNELL, 1939), *Diceratopyge* and *Dichelepyge* (HARRINTON and LEANZA, 1957).

Occurrence:—*Iwayaspis* zone; boulders of black shale at loc. 313. The detached carapaces from black shales at locs. 196 and 199 are, though badly deformed, referred provisionaly to this species.

Family Uncertain

Meraspid, gen. et sp. indt.

PA4036

Plate VIII, Figure 16.

Small cranidium, very broad and trapezoidal; glabella long, conical, rounded in front; glabellar furrows obsolete; occipital and dorsal furrows deep; breadth of fixed cheek equal to cranidial length; eyes opposed near the anterior of glabella; frontal limb short; frontal rim straight and wire-like.

Occurrence:—Black shale at loc. 199. *Komaspis megalops*, *Eochuangia hana* and *Proceratopyge rotundum* are found at the same locality.

Meraspid (?) gen. et sp. indt.

PA4153

Plate VIII, Figure 15.

Small immature cranidium, subtrapezoidal in outline; glabella clavate, twice as long as broad, narrow, distinctly tapering backward and unfurrowed except an occipital furrow; palpebral lobes small, located anterior to mid-length of the cranidium; fixed cheek much wider than glabella even though eyes and its postero-lateral limb large; palpebral lobe small; frontal limb moderate in size; frontal rim narrow and straight.

Occurrence:—Black shale at loc. Ita 11.

Free cheek and Pygidium, gen. et sp. indt.

PA4162-5-19
PA4163-5-20

Plate V, Figures 19 and 20.

A fragmentary pygidium having a depressed border and long falcate flat lateral spine reveals a form distinct from all of the above described species. The border is defined inside by no marginal furrow. The axial lobe seems relatively narrow and terminates on the inner margin of the border. Because the spine issues from the anterior segment of the pygidium and the posterior margin between the spines is remarkably rounded, it does not belong to either *Crepicephalina* or *Koptura*. Compared to the known species of *Proceratopyge*, its spine is so distinctly falcate and the posterior margin is so broadly rounded. The associated free cheek (pl. 6, fig. 19), however, looks like *Proceratopyge*. It is certain that the pygidium represents an undescribed species, but a better material is needed to say its taxonomic position.

Occurrence:—*Eochuangia* zone at loc. 274.

Two immature pygidia, gen. et sp. indt.

PA4164-5-6
PA4165-5-23

Plate V, Figures 6 and 23.

A small pygidium from loc. 262 (fig. 23) is semicircular in outline and trisegmented in the anterior major half; axial lobe one-fourth as wide as pygidium, elevated above gently inflated pleural lobes; marginal border narrow and depressed.

Another immature pygidium from loc. 261 (fig. 6) is similar to the preceding in outline, but the segmentation is obscure and the marginal border absent.

The latter is found together with *Haniwoides puteolatus* and *Eochuangia hana* and the former occurs in association with *Haniwoides tenuis*, *Komaspis convexus* and *Proceratopyge rotundum*. One of the possibilities for these pygidia is to belong to immature holaspids of *Haniwoides*.

Occurrence:—*Eochuangia* zone at locs. 261 and 262.

Two Hypostomata, gen. et sp. indt. PA4166-1-12
Plate I, Figure 12; Plate II, Figure 5. PA4167-2-5

A hypostoma in fig. 11, pl. 1 is extraordinarily elongated and the median body remarkably vaulted. It is, however, very similar to another in fig. 5, pl. 2 which is strongly depressed in the axial direction. The very large median body is similarly separated from the lunate posterior ridge by a depression which is more or less shallower on the axis. They are surrounded by a narrow marginal furrow and rim. The anterior and posterior margins are more arcuate in the long form than the other. Both of them have a pair of small antero-lateral wings.

It is certain that they are secondarily deformed by axial depression or lateral compression. If the amount of deformation can be considered so great that the original form was intermediate between the two, it is presumable that the original form in question was not essentially different from that of *Kootenia punctata* in fig. 18, pl. 15, 1935.

As shown in table 2, loc. 109 is a rich fossil locality whence *Kootenia punctata*, *Olenoides asiaticus* and many other polymeric trilobites were collected. Among them it is quite probable for these hypostomata to belong to any species of the Dorypygidae.

Occurrence:—*Tonkinella* zone at loc. 109.

IV. Notes on the Major Classification of Cambrian Trilobites of Asia.

As reviewed on some occasions (1950, 60), studies on the trilobites were greatly developed into various trends in recent years. Several salient conclusions were introduced as the result: The Trilobita are now promoted an independent class of the Arthropoda. It is known to have been widely diverged already at the beginning of the Cambrian period when four major stocks were existed. They reveal the Agnostida, Redlichiida, Corynexochida and Ptychopariida where the first is miomeric and the three others can be combined into the Polymera.

The Miomera or Agnostida represent a relatively small but highly speci-

alized group in the Cambro-Ordovician period, on which I have given some remarks on the preceding pages.

Among the three polymeric orders, the Redlichiida and Ptychopariida are respectively short and long ranged, the Corynexochida being intermediate. Some orders and suborders were secondarily issued from the Ptychopariida and Corynexochida from time to time. The greatest change of the Trilobita has taken place near the transition from Cambrian to Ordovician when several new orders or suborders appeared.

Compared to the post-Cambrian trilobites, the Cambrian ones are not so well known and accordingly some fundamental questions still remain unsolved in their taxonomy. Like the post-Cambrian ones, the studies on the Cambrian trilobites were initiated in Europe and the Olenidian, Paradoxidian and Olenellian faunas are now well clarified on the Atlantic side. But these trilobites on the whole occupy only a smaller part of the Cambrian faunas of the world and many others have flourished in Asia, Australia, Americas and the Arctic province. Much remains to be explored in the Cambrian strata of the Cordilleran and the Andine geosyncline. A considerable number of new trilobites were recently described from Asia, North Africa and South America and numerous new genera and species and some new families were established for them. Many other finds were reported from Australia. Thus it is certain that the Asio-Pacific trilobites constitute a very important part of the Cambrian faunas. Therefore their classification must be reconsidered in the light of new facts.

It was some 25 years ago that I have once discussed this problem in the third part of this publication. Lately I have resumed this study. As to most of the oriental genera all species involved in them have been brought into consideration. I attempted further to study most Asiatic Cambrian genera as much as possible to seek their mutual relationship. The results thus obtained were compiled successively in the parts VI, VII, VIII and IX. Now I came to the end of the last part where the relation of the families to the order is left to be discussed. Therefore I shall take up this problem with special attention to the Asiatic or Pacific Cambrian families.

I have already pointed out that no classification of trilobites can be established on the basis of a single biocharacter. The facial suture bears of coarse great value for taxonomy, but it could be no more than a criterion. The outline of the glabella and its furrows on which HENNINGSMOEN (1951) laid special weight cannot be exceptions. For the natural classification the combination of evolutional characters must be thoroughly investigated and the morphic connection or the *Formenreihe* should be carefully traced. If such a morphological series can be reasonably traced through the geological ages and geographical provinces, then it may be accepted as a phylogenetical series. Such a specio-temporal sequence is, however, not always traceable.

From such a point of view especially important at this moment are the Corynexochida and certain families which have flourished in the Asio-Pacific province in the Cambrian period.

Order Redlichiida

RICHTER (1933) has united in the Redlichiina four superfamilies, viz. the Redlichiidea, Zacanthoidea, Bathyuriscidea and Dikelocephalidea, but I have erected the Corynexochida and Dikelocephalida (1935), because the former indicates an independent lineage since the early Cambrian epoch and because the derivation of the latter from the Redlichiida or any other stock was indeterminable at that time, although it was found later that the Dikelocephalida have originated probably in the Ptychopariida (1937).

Still later (1948) RASETTI connected the Zacanthoididae with the Corynexochoidae, saying that "an almost continuous series of genera bridging the gap between *Zacanthoides* and *Bathyuriscus* is now known" (1951, p. 239). HENNINGSMOEN agreed with him, in the conjunction, but applied the Zacanthoidacea, instead of the Corynexochoidae, for the term.

HENNINGSMOEN (1951) recognized 11 superfamilies among polymeric trilobites, but most of them were considered derivatives from the Conocoryphacean stock (or Ptychopariida) and even the Redlichiacea were taken for an early off-shoot from the same stock. According to him two isolated groups are the Olenellaceae and Zacanthoidacea.

Our knowledge on the Redlichiida was greatly amplified by the studies on the Lower Cambrian faunas in Spain and Morocco respectively by RICHTERS (1940, 41) and HUPÉ (1952). At length the protolenids, ellipsocephalids and even bathynotids were all brought into the Redlichioidae by HUPÉ (1953). However, a separate suborder, Bathynotina, was soon erected in the Redlichiida (Treatise, 1959). Then the Bathynotinae were brought back again in the Komaspidae as a subfamily (Principles, 1960). The bathynotids are indeed intimate to the komaspids as I have discussed in detail (1954). It is further a remarkable fact that the Redlichioidae are well represented in Siberia with many new genera.

At present some additions are required to the Mesonascida, i. e. Redlichiida which I figured in 1935 and also some subtractions from the order.

Redlichidae
Paradoxidae
Olenopsidae i. e. Dolenolenidae
Zacanthoidae, Lancastridae } to Corynexochida
Burlingidae....to Ptychopariida
Kainellidae i. e. Richardsonellidae, Remopleuridae } to Ptychopariida (?)
Ceratopygidae....to Asaphina
Protolenidae, Ellipsocephalidae } from Ptychopariida

Order Corynexochida

When I have estabilshed the Corynexochida, 1935, it comprised 8 families

Table 7. Taxonomy of the Komaspids, Damesellids and Remopleurids.

Author \ Taxon	Bathyrotidae (*Bathynotus*)	Komaspididae	Damesellidae	Leiostegiidae	Remopleuridae
RAYMOND 1913	(Olenidae)				Remopleuridae
RICHTER 1932					Zacanthoididae
KOBAYASHI 1935	Corynexochida	Corynexochida	Corynexochida	Corynexochida	(Redlichida) Mesonacida
HENNINGSMOEN 1951	Zacanthoidacea	Conocoryphacea	Conocoryphacea	Conocoryphacea	Dikelocephalacea
HUPÉ 1953-55	Redlichioidae	Telephoidae	Olenoidae	Olenoidea	Olenoidea
Treatise 1959	Redlichiida	Ptychopariina	Ptychopariina	Ptychopariina	Ptychopariina
Principles 1960	Telephoidae	Telephoidae	Dikelocephaloidae	Dikelocephaloidae	Ptychoparioidae

Table 8. Corynexochida KOBAYASHI, 1935.

Family	Cambrian	Ordovician	Silurian	Devonian	Superfamily
Triniidae					Corynexochacea
Corynexochidae					ANGELIN
Dorypygidae					Dorypygacea KOBAYASHI
Oryctocephalidae					Oryctocephalacea BEECHER
Bathynotidae					Komaspidacea
Komaspidiidae					
Telephinidae					KOBAYASHI
Zacanthoididae					Zacanthoidacea SWINNERTON
Dolichometopidae					Dolichometopacea
Erbiopsididae					
Edelsteinaspidae					
Ogygiopsidae					WALCOTT
Jakutidae					
Damesellidae					Damesellacea
Kaolishaniidae					KOBAYASHI
Namanoiidae					Leiostegiacea
Leiostegiidae					
Pagodiidae					BRADLEY
Amgaspididae					Eoacidaspidacea
Eoasidaspididae					POLETAYEVA
Odontopleuridae					Odontopleuracea BURMEISTER
Lichidae					Lichacea HAWLE and CORDA

in addition to 10 subfamilies. Among them the Corynexochidae, Dolichometopidae, Oryctocephalidae and Dorypygidae are now generally accepted as the members of the order. Some authors eliminated the Komaspidae, Damesellidae, Leiostegiidae, Lloydiidae and Pagodiidae, without stating sufficient reasons to do so. Their references to the higher taxons greatly disagreed among the authors, as shown in the table 8. Beside these there are 10 families which were referred to the Corynexochida or the Corynexochoidae by various authors as follows:

Zacanthoididae SWINNERTON, 1915
Dinesidae LERMONTOVA, 1941
Ogygiopsidae RASETTI, 1951
Edelsteinaspidae HUPÉ, 1953
Protypidae HUPÉ, 1953
Proerbiidae HUPÉ, 1953
Triniidae POLETAYEVA, 1956
Jakutidae SUVOROVA, 1960
Amgaspidae TCHERNYSHEVA, 1960
Erbiopsididae KOBAYASHI, 1961

As noted already (1954), komaspids and bathyonotids constitute a solid group with telephinids. Although the glabella tapering forward in the Bathynotinae, the subfamily best agrees with the Dolichometopidae in many major aspects. Therefore the closest ally to the Komaspididae must be the Dolichometopidae.

The Damesellidae have been described in a great detail already in some papers (1941-1956). In my opinion the oldest two members of the family are *Inouyina* and *Chaskasskia*. Recently *Chaskasskia* and *Inouyina* were respectively referred to the Dorypygidae and the Namanoidae by SUVOROVA (1960). It can hardly be overlooked that *Namanoia* and *Jakutus* have the same kind of the cephala, and their pygidia and thoracic segments are also similar. These two genera show the close affinity of the Namanoidae and Jakutidae to the Leiostegiidae, although the Jakutidae are considered a family of the Corynexochoidae in Principles (1960). The above facts on the whole mean that the Leiostegiidae and Damesellidae are connected to the Corynexochida through the Dorypygidae, Namanoidae and Jakutidae. On the contrary, their intimacy to the Ptychopariidae, Olenidae or any other family of the Ptychopariida has never been pointed out actually.

I am of opinion that in view of the annelid-derivation of the trilobites, the subcylindrical glabella, more or less tapering forward and regularly annulated by glabellar furrows, as seen in *Redlichia*, reveals the original aspect of the primitive trilobite. The outline of the glabella changes in one way by the expansion of the anterior part or in another by the triangulation or the posterior expansion. If the expansion occurs on the two sides, the aquired glabella is urceolate, as in many asaphids. The lateral furrows change their direction and strength, caused by the change of the glabellar outline as well as the effacement of the furrows and other relieves which advances as a rule

from distal to proximal on the Trilobita, that is, from anterior to posterior on the glabella. These evolutional trends are typically illustrated among agnostids, but they are well observable also among polymeric trilobites. Any part of the cephalon is however, after all no more important than the fundamental configuration of the part of the cephalon.

The Lloydiidae agree with the Leiostegiidae except for the difference of the glabellar outline. Therefore the Lloydiidae to the Leiostegiidae is comparable to the Kaolishaniidae to the Damesellidae. The Pagodiidae reveal a branch of similar trilobites to the Leiostegiidae, but diminitive forms. Except for the North American Lloydiidae of which only one genus is known in Eastern Asia, all of these families have flourished in various Cambrian areas of Asia. Some of them occur in Australia. In the Lower Ordovician period the Leiostegiidae and the Kaolishaniidae were distributed widely in the circum-Pacific regions. Thus it is better ascertained than before, that these families are corynexochideans. Now I consider it proper to group the Namanoidae, Oryctocephalidae, Damesellidae, Kaolishaniidae, Leiostegiidae, Pagodiidae and probably Lloydiidae in a new suborder, Damesellina, in the order Corynexochida.

The Zacanthoididae and Ogygiopsidae are now generally referred to the Corynexochida. At the same time it may be accepted that the Triniidae are related most intimately to the Corynexochidae and that the Edelsteinaspidae and Jakutidae in addition to the Erbiopsididae are also closely allied to the Dolichometopidae. *Protypus* (or *Bicaspis* RESSER, 1938) which simply differs from *Bonnia* in the number of thoracic segments and size and shape of the pygidium (RASETTI, 1948) is nothing but a member of the Dorypygidae.

Though still very tentative, the Corynexochida may be classified into two or more suborders, each involving a few superfamilies. The new classificatory scheme of the two suborders is proposed here as follows:

Suborder Corynexochina, nov.: Glabella mostly parallel-sided or forwardly expanded; fixed cheeks usually narrow; palpebral lobes often well developed.

Corynexochacea nov.: Most pygidia having entire margins. Corynexochidae, Dolichometopidae, Triniidae, Ogygiopsidae, Erbiopsididae, Edelsteinaspidae.

Komaspidacea nov.: Similar to the preceding, but the glabella parallel-sided or backwardly expanding. Komaspididae, Telephinidae.

Dorypygacea nov.: Pygidium mostly spiniferous. Dorypygidae, Zacanthoididae.

Suborder Damesellina nov.: Glabella mostly subcylindrical or tapering forward, fixed cheek relatively broad and palpebral lobes commonly medium in size.

Damesellacea nov.: Pygidium mostly spiniferous. Damesellidae, Oryctocephalidae.

Namanoiacea nov.: Pgygidium mostly with entire margin. Namanoidae, Jakutidae, Leiostegiidae, Lloydiidae, Pagodiidae, (?) Dinesidae.

Among the recent discoveries of Cambrian trilobites in Siberia and Kazakstan quite unexpected are the find of the Cambrian odontopleuroids. They

are the following four genera:

Amgaspis TCHERNYSHEVA, 1956, (*Amgaspis medius* TCHERNYSHEVA). Middle Cambrian, rarely late Lower Cambrian; Siberia.

Acidaspides LERMONTOVA, 1951, (*Acidaspides precurrens* LERM.) Middle Cambrian of Siberia and Upper Cambrian of Kazakstan.

Belovia POLETAYEVA, 1956, (*Belovia clava* TCHERNYSHEVA). Upper Cambrian of Siberia.

Eoacidaspis POLETAYEVA, 1956, (*Eoacidaspis salairensis* POLETAYEVA). Upper Cambrian of Siberia.

While TCHERNYSHEVA (1960) erected the Amgaspidae in the Corynexochida, the three others were referred to either the Odontopleuridae or the Eoacidaspidae POLETAYEVA (1960) which in turn belong to the Odontopleuroidae. Previously I have suggested that the lichids and odontopleurids were probably introduced from the Zacanthoididae, although there was a wide gap of the late Cambrian period. Through these genera the Odontopleurida are now linked with the Corynexochida. It is highly probable that the Lichacea have sprung out also from any of the Corynexochida directly or through any Cambrian odontopleuroids.

Little is as yet known of the Cambrian ancestors of the cheirurids, encrinurids or phacopids. Their origin is at present one of the interesting problems in trilobitology. Is there any possibility for the cheirurids to have been derived from the corynexocidean stock? If the proparian suture beside some differences of eyes and others are ignored, the great similarities of the primitive cheirurids to the damesellids can hardly be overlooked. In view of the resemblances I think that future researches may discover any indispensable link in the vast terrain of the Asio-Pacific areas. Therefore I said that the Cheirurina and probably Phacopina may have developed somewhere near the Damesellidae (1960).

Finally, I think that it is still another problem whether the Remopleuridacea are really ptychoparian derivatives, or whether the resemblance of the superfamily with the Zacanthoididae is something more than a simple example of homoeomorphism.

Order Ptychopariida

In Asia this order is represented in the Cambrian fauna by the following families or higher taxons. Those appeared in Asia in the Ordovician period are cited with brackets.

Suborder Ptychopariina RICHTER, 1932.

Superfamily Ptychopariacea MATTHEW, 1887.

Ptychopariidae, Solenopleuridae, Dokimocephalidae, Olenidae, Emmrichellidae, (Bathyuridae)

Superfamily Conocoryphacea ANGELIN, 1854.

Conocoryphidae

Superfamily Agraulacea RAYMOND, 1913.

Argaulidae, Ptychaspididae, Shumardiidae
Superfamily Asaphiscacea RAYMOND, 1924.
Conokephalinidae, Asaphiscidae, Tsinaniidae, Anomocaridae, Monkaspidae, Crepicephalidae, Elviniidae
? Superfamily Remopleuracea HAWLE and CORDA, 1847.
? Richardsonellidae, (Remopleuridae)
Suborder Burlingina KOBAYASHI, 1954.
Burlingidae
Suborder Dikelocephalidina KOBAYASHI, 1935.
Superfamily Dikelocephalacea MILLER, 1935.
Dikelocephalidae, (Dikelocephalinidae, Birmanitidae)
Suborder Asaphina SALTER, 1864.

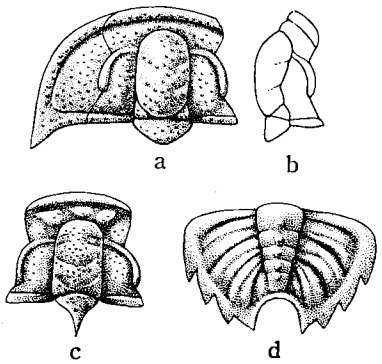

Figure 14.
a-b. *Botomella ekaterinae* SUVOROVA
c. *Proerbia prisca* LERMONTOVA
d. *Agyrenella macropleura* IVSHIN

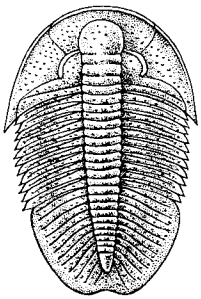

Figure 15. *Granularia protolenorum* PALETAYEVA in LERM. 1951.
The thorax is said to have 12 segments (SUVOROVA, 1959) or 10 segments (Principles, 1960).

Superfamily Ceratopygacea LINNARSSON, 1869.
Ceratopygidae, Granularidae (Fig. 15)
Superfamily Asaphacea BURMEISTER, 1843.
Asaphidae, (Taihungshaniidae, Nileidae, Cyclopygidae)
(? Suborder Illaenina JAANUSSON, 1959)
(Suborder Calymenina SWINNERTON, 1915)
(Suborder Harpina WHITTINGTON, 1959)
(Suborder Trinucleina SWINNERTON, 1915)

Class Trilobita

The major classification of the Trilobita is here emended in the following manner.
Subclass Miomera JAEKEL, 1909

Order Agnostida KOBAYASHI, 1935
Suborder Eodiscina KOBAYASHI, 1939
Suborder Agnostina SALTER, 1864
Subclass Polymera JAEKEL, 1909
Order Redlichiida RICHTER, 1933
Suborder Olenellina RESSER, 1938
Suborder Redlichiina HARRINGTON, 1959
Order Corynexochida KOBAYASHI, 1935
Suborder Corynexochina KOBAYASHI, nov.
Suborder Damesellina KOBAYASHI, nov.
Suborder Odontopleurina WHITTINGTON, 1959
? Suborder Lichina MOORE, 1959
Order Phacopida SALTER, 1864
Suborder Cheirurina HARRINGTON and LEANZA, 1957
Suborder Phacopina STRUVE, 1959
Order Ptychopariida SWINNERTON, 1915
Suborder Ptychopariina RICHTER, 1933
Suborder Burlingina KOBAYASHI, 1954
Suborder Dikelocephalidina KOBAYASHI, 1935
Suborder Asaphina SALTER, 1864
? Suborder Illaenina JAANUSSON, 1959
Suborder Calymenina SWINNERTON, 1915
Suborder Harpina WHITTINGTON, 1959
Suborder Trinucleina SWINNERTON, 1915

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Postscript

A recent paper on the "Cambrian trilobites from Sandu and Duyun, Southern Kweichou" by CHIEN YIN-YUAN (1961), *Acta Pal. Sinica, Vol. 9, No. 2*, includes 6 new genera and 1 new subgenus (type-species in brackets) beside a new family, as follows:

1. *Balangia* CHIEN, (*B. balangensis* CHIEN, Lower Cambrian), small isopygous trilobites, 4 segmented in throax; glabella nearly parallel-sided, broad and long enough to reach the anterior border; eyes large; free cheek narrow, provided with a short genal spine; pygidium rounded with 9-10 axial rings and 7-8 pleural segments. This is a polymerid but nearest to the *Miomera* or the *Eodiscina*. A new family Balangiidae is erected in the Corynexochida.
2. *Changaspsis* LEE in CHIEN, (*Changaspis elongata* LEE in CHIEN), a Lower Cambrian genus of the Oryctocephalidae. *Changaspis micropyge* CHIEN is the second species having 14 segments in thorax and a tiny pygidium whence a relatively long post-axial spine issues. This must be the second genus of the Lancastrinae.
3. Late Lower Cambrian *Kootenia* (*Duyunia*) *constrictus* CHIEN, monotypic of *Duyunia* CHIEN which is 6-segmented in thorax and has the glabella constricted in anterior, but otherwise most allied to *Kootenia* s. str.
4. *Chekiangaspis* LU in CHIEN (*C. chekiangensis* LU in CHIEN, late Upper Cambrian) has the cephalon similar to that of *Acrocephalina*. Its thorax is, however, 12-segmented; the fourth axial and the occipital ring bear a long spine. The genus is referred to the Agraulidae.

5-6. *Sanduspis* CHIEN (*S. gracilis* CHIEN) and *Guizhoicephalina* CHIEN (*G. longispina* CHIEN) are two Upper Cambrian genera placed in the Ptychopariidae. The latter genus has the long flexuous genal spine as seen in *Eurycare* and *Ctenopyge*, but it is more similar to *Paraeuloma* in the general aspect of the cephalon. The former resembles the latter, but has the wider and more convex anterior border, deep anterior border furrow, large eyes, comparatively narrow fixed cheek and lack of no intergenal spine. From *Proaulacopleura* the former is distinguished by the narrower frontal rim, broader fixed cheek and 12, instead of 14 segments in thorax.

7. *Pseudoyuepingia* CHIEN (*Pseudoyuepingia modesta* CHIEN, Upper Cambrian) has 9-segments in thorax, but taken for a member of the Niobinae, allied to *Niobella*.
8. *Pagodia duliujiangensis* CHIEN (Upper Cambrian) is represented by a complate dorsal segments on which 10 segments are enumerated on the thorax.

Four new gencra were established with the Lower Ordovician trilobites from Kazakstan through the follows papers:

LISOGOR, K. A. (1961), Trilobites from the Tremadocian and adjoining Formations in Kazakstan. *Trudi Pal. Inst. Tom. 18, Acad. Nauk, U. S. S. R.*

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Agalatus LISOGOR, (*A. cavernosus* LISOGOR).....Olenidae
Alimbetaspis BALASHOVA, (*A. Kelleri* BALASHOVA) .....Olenidae
Bicornipyge LISOGOR, (*B. bicornis* LISOGOR).....Ceratopygiidae
Kasachstanaspis BALASHOVA, (*K. macroura* BALASHOVA) .....Dikelocephalidae

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T. KOBAYASHI

The Cambro-Ordovician Formations and Faunas of South Korea, Part IX
Palaeontology, VIII

The Machari Faunas

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1 PA4075


2 PA4074


7 PA4099


3 PA4025


5 PA4122


8 PA4092


9 PA4093


6 PA4123


4 PA4026


10 PA4094


13 PA4101


14 PA4050


12 PA4166


15 PA ~~3989~~

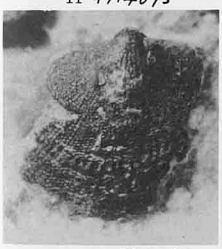

11 PA4095


18 PA4084


22 PA4021


16 PA4057


17 PA4052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20b PA4112


20a


19 PA4088


24 PA4023


26 PA4096


23 PA4022


25 PA4024

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1 PA4079

4 PA4107

2 PA4077

8 PA4125

3 PA4078

12 PA4067

5 PA4167

7 PA4041b

10 PA4065

6 PA4097

16 PA4098

15 PA4025

11 PA4066

14 PA4085

PA4125 9

18 PA4126

PA4127 19

17 PA4100

20a

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13 PA4068

21b

21a

PM3990

22 PA4039

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1 PA3993

2 PA3995

3 PA3994

4b PM3991 4a

10 PA4019

15 PA4011

7 PB3988

6 PB3987

5 PM3992

11 PA4020

12 PA3997

14 PA3999

13 PA3998

8 PB3985

19 PA4129

18 PA4128

16 PA4012

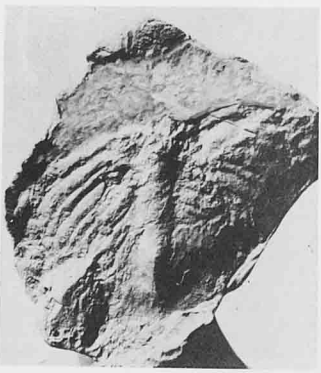
17 PA4013

9 PB3984

20 PA4130

PA433

23



21 PA4131

24 PA4121

22 PA4132

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1 PA4040


2 PA4041


5 PA4135


7 PA4137


6 PA4136


4 PA4070


3 PA4069


8a PA4128


8b


11 PA4140


10 PA4139


9 PA4138


12 PA4141


18b PA4104


18a


19 PA4105


16 PA4145


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1 RA4082


2 RA4134


3 RA4037


5 RA4083


6 RA4164


7 RA4106


9 RA4015


8 RA4014


13 RA4124


10 RA4016

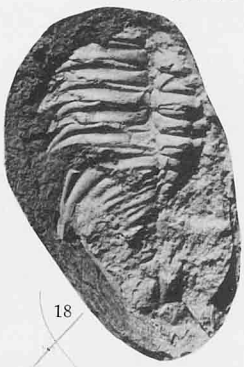

11 RA4017


12 RA4018


14 RA4081


16 RA4030


19 RA4162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15a


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21 RA4102


23 RA4165


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17 RA4031


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Explanation of Plate VI

Iwayaspis asaphoides KOBAYASHI, new gen. and species .....p. 122

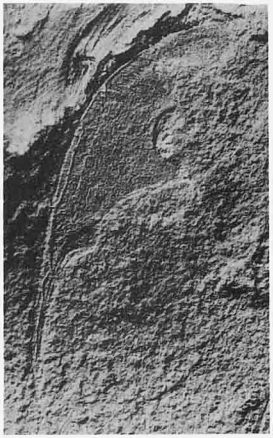
Figure 1. Holotype dorsal shield without free cheeks, ×3.
Figure 2. Free cheek, ×3.
Figure 3. Cranidium with 4 thoracic segments, ×3.
Figure 4. Incomplete immature dorsal shield, ×5.
Figure 5. Cephalon and thorax; hypostoma partly exposed; ×1.5
Figure 6. Detached hypostoma, ×3.
Figure 7. Thoracic segments and pygidium, ×1.5
Figure 8. Immature thorax and pygidium, ×3.
Figure 9. Detached free cheek and thoracic segment, ×1.5
Figure 10. Pygidium, ×3.
All from loc. 313.

Proceratopyge (*Lopnorites*) *rectispicatus* TROEDSSON .....p. 120

Figure 11. Pygidium, ×1.5
Figure 12. Pygidium showing doublure, ×1.5
Both from loc. 313.

Proceratopyge (*Lopnorites*?) *robustus* KOBAYASHI, new species .....p. 121

Figure 13. Pygidium, ×1.5 Loc. 313.



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4 PA 4002

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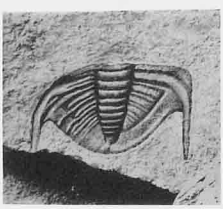
12 PA 4149



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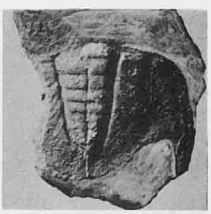

13 PA 4150

Explanation of Plate VII

Koptura bispinata KOBAYASHI, new species ..... p. 101

Figure 1. Incomplete cranidium, ×1.5 Loc. 197.
Figure 2. Holotype cranidium, ×1.5 Loc. 197.
Figure 3. Paratype pygidium, ×2. Loc. 197.
Figure 4. Small cranidium, ×2. Loc. 199.
Figure 5. Free cheek, ×2. Loc. 199.
Figure 6. Pygidium, ×2. Loc. 196.
Figure 7. Cranidium, ×1.5 Loc. 313.

Eochuangia hana subsp. *conica* KOBAYASHI ..... p. 35

Figure 8. Cranidium, ×1.5
Figure 9. Free cheek, ×1.5
Figure 10. Thoracic segment, ×2.
Figure 11. Pygidium, clay-cast, ×3.
Figure 12. Meraspid cranidium, ×10.
Figure 13. Meraspid cranidium, ×10.
All from Loc. 196.
Figure 14. Free cheek, ×2. Loc. 199.

Proceratopyge (*Kogenium*) *rotundum* KOBAYASHI ..... p. 120

Figure 15. Immature pygidium, ×3. Loc. 199.

2 PA 4114

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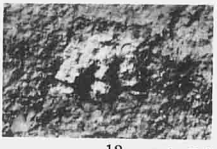

12 PA 4035

15 PA 4036

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6 PA 4118

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3 PA 4115

Explanation of Plate VIII

Homagnostus hisakoshii KOBAYASHI, new species.....p. 30
Figures 1-2. Two cephala, ×5. Loc. 313.
Figure 3. A cephalon and pygidium, ×5. Loc. ditto.
Figure 4. Two pygidia disposed subrectangularly, ×5. Loc. ditto.
Figure 5. Two thoracic segments and a pygidium, ×5. Loc. ditto.
Figure 6. An immature pygidium, ×10. Loc. ditto.
Figure 7. Pygidium, ×5. Loc. ditto.
Figure 8. Pygidium, ×5. Loc. 196.
Figure 9. Nearly complete dorsal shield, holotype. ×5. Loc. 197.
Figure 10. Cephalon, ×8. Loc. Ita. 11.
Figures 11-13. Three pygidia, ×8. Loc. ditto.
Figure 14. Small pygidium, ×5. Loc. ditto.

Meraspid (?), gen. et sp. indt.....p. 124
Figure 15. Immature cranidium, ×8. Loc. Ita 11.

Meraspid, gen. et sp. indt.....p. 124
Figure 16. Immature cranidium, ×5. Loc. 199.

Komaspis (*Parairvingella*) *megalops* KOBAYASHI, new species.....p. 37
Figure 17. Holotype cranidium, ×3. Loc. 196.
Figure 18. Cranidium, ×2. Loc. ditto.
Figure 19. Free cheek, ×3. Loc. ditto.
Figure 20. Pygidium, ×2. Loc. 199.
Figure 21. Four thoracic segments, ×3. Loc. 313.
Figure 22. Cranidium, ×3. Loc. ditto.

Ctenopyge (?) sp. indt.....p. 56
Figure 23. Free cheek, ×2. Loc. 196.

Iwayaspis asaphoides, new species .....p. 122
Figure 24. Two pygidia, ×3. Loc. 196.

Proceratopyge (*Kogenium*) *rotundum* KOBAYASHI,.....p. 120
Figure 25. Pygidium, ×2. Loc. 199.


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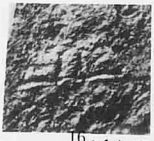
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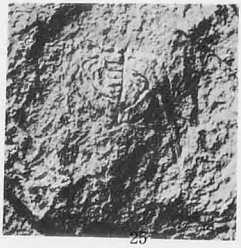
25 PA4117

Explanation of Plate IX

Rhodonaspis (?) *similis* KOBAYASHI, new species ..... p. 59
Figure 1. Cranidium, ×4. Loc. 242.

Hancrania brevilimbata KOBAYASHI, new species ..... p. 55
Figure 2. Holotype cranidium and a hypostoma, ×3. Loc. 242.
Figure 3. Paratype cranidium, ×3, Loc. ditto.
Figure 4. Another paratype cranidium, ×3. Loc. ditto.
Figure 5. Meraspid cephalon, ×ca 10. Loc. ditto.
Figure 6. Meraspid cephalon in a later stage, ×ca 10. Loc. ditto.

"*Hedinaspis*" *granulatum* KOBAYASHI, new species ..... p. 58
Figure 7. Holotype cranidium, ×3.5. Loc. 242.

"*Westergaardella*" *coreanica* KOBAYASHI, new species ..... p. 78
Figure 8. Holotype cranidium, ×2. Loc. 242.

Phalacromina minor KOBAYASHI, new species ..... p. 29
Figure 9. Holotype cranidium, ×10. Loc. 242.

Glyptagnostus reticulatus (ANGELIN) ..... p. 27
Figure 10. Cephalon, ×4. Loc. 241.
Figure 11. Another cephalon, ×5. Loc. ditto.
Figure 12. Small cephalon, ×4. Loc. ditto.
Figure 13. Pygidium, ×4. Loc. ditto.
Figure 14. Another pygidium, ×3. Loc. Matsutoge.
Figure 15. Thoracic segment, ×4. Ita 1.

Olenus asiaticus KOBAYASHI ..... p. 54
Figure 16a-b. Holotype cranidium, ×3. Loc. Ita 1.

Acrocephalina trisulcata KOBAYASHI ..... p. 73
Figure 17. Holotype cranidium, ×4. Ita 1.

Conokephalina ornata BRÖGGER ..... p. 76
Figure 18. Plaster cast of holotype cranidium, (RESSER photo.). Middle Cambrian, Krekling (1c), Norway.

Koptura lisani (WALCOTT) ..... p. 101
Figure 19. Pygidium, ×2. Sea-shore of Niang-niang-kung, Tschanghsingtao, Fuhisen, Prov. Liaoning.

Proceratopyge (*Kogenium*) *rotundum* KOBAYASHI ..... p. 120
Figure 20. Ventral side of pygidium, ×3. Loc. 93003.
Figure 21. Two free cheeks united by a doublure, ×3. Loc. ditto.

cfr. *Proceratopyge* (*Lopnorites*) *robustus* KOBAYASHI, new species ..... p. 121
Figure 22. Hypostoma, ×4. Loc. Ita 11.

Proceratopyge (*Lopnorites*) *robustus* KOBAYASHI, new species ..... p. 121
Figures 23a-b. Hypostoma, ×3. Loc. 313.

Iwayaspis cfr. *asaphoides* KOBAYASHI, new species ..... p. 122
Figure 24. Free cheek, ×2. Loc. 199.


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12 PA1996


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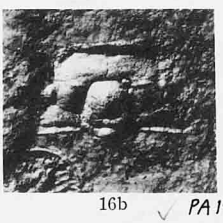
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16a PA1991


22 PA4153


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20 PA4147


17 PA1993


14 PA2000


15 PA1993


23a PA4151


23b PA4152


21 PA4147


24 PA4044b

Explanation of Plate X

Ptychoparia kochibei WALCOTT ..... p. 42
Figures 1–2. Two cranidia, ×1. Loc. Wuhutsui basin, (41).
Figure 3. Cranidium and a few thoracic segments, ×1. Loc. ditto.
Figure 4. Free cheek, ×1. Loc. ditto.

Tingocephalus concavolimbatus (ENDO) ..... p. 35
Figure 5. Plaster-cast of the holotype cranidium of *Parakoldinioidia concavolimbata* ENDO, in fig. 20, pl. 70, ENDO and RESSER, 1937. ×2. Loc. Daizanian limestone on a slope of the 140 m. hill, 1km. north of Lashufang on Tschang-hsing-tao, Fu-chou-hsien, Liaoning.

Mesocrepicephalus subquadratus KOBAYASHI ..... p. 75
Figures 6–7. Two cranidia, ×2.5 Loc. 304.

Ptychoparia bipuncta KOBAYASHI, new species ..... p. 44
Figure 8. Cranidium, ×5. Loc. 109.

Mesocrepicephalus airaghii KOBAYASHI ..... p. 75
Figure 9. Cranidium, ×5. Loc. 302.

Yongwolia kagasi KOBAYASHI, new sp. ..... p. 64
Figure 10. Cranidium, ×10. Loc. Ita 10.

Metagraulos cfr. *coreanicus* KOBAYASHI ..... p. 66
Figure 11. Cranidium, ×1.5 Loc. Dai 1.

Koptura cfr. *bispinata* KOBAYASHI, new species ..... p. 103
Figure 12. Clay-cast of a Pygidium, ×1.5. Loc. 199.

Amphoton deois (WALCOTT) ..... p. 34
Figure 13. Cranidium, ×3. Loc. Rinson shale of Chunghwa area (D 1).

Elrathia chuwaensis KOBAYASHI, forma *rinsonica*, n. f. ..... p. 47
Figure 14. Imperfect dorsal shield, ×2. Loc. Rinson shale of Chunghwa area, (SAITO collection, Loc. G 4).
Figure 15. Nearly complete dorsal shield, ×3. Loc. ditto. (SAITO collection, Loc. G 1).

"Iddingsia" orientalis KOBAYASHI ..... p. 72
Figure 16. Cranidium, ×2. Loc. Tanyo 7, Valley in the north of Hyonchonni, Tan'gyang-myŏn, Tan'gyang-kun, Ch'ungch'ong-bukto.

Hamashania (?) sp. ..... p. 70
Figure 17. Imperfect pygidium, ×1.5 Loc. ditto.

Kingstonia parallela KOBAYASHI ..... p. 70
Figures 18a-b. Dorsal and lateral views of the cranidium, ×3. Loc. Tanyo 9, West side at the mid-way between Song-hyon and Kosu-ri, Kangong-myŏn, Tan'yang-kun, Ch'ungch'ong-bukto.

Plethometopus longispinus KOBAYASHI ..... p. 68
Figure 19. Cranidium, ×4. Loc. Tanyo 7.


1 PA 4047


2 PA 4047


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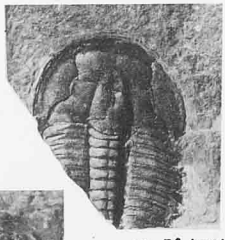
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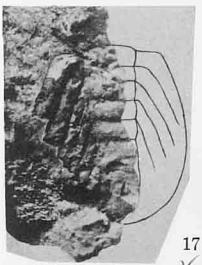
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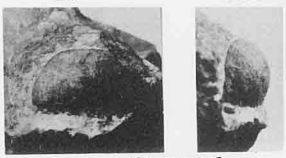
18a 18b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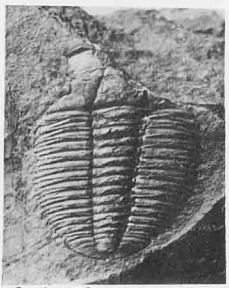

15 PA 4055

Explanation of Plate XI

Elrathia hoboi RESSER and ENDO ..... p. 48

Figures 1-3. Three early holaspids, ×10.

Figures 4-6. Three middle holaspids, ×4.

Figure 7. Late holaspid, ×3.

Figure 8. Full grown holaspid cranidium, ×2.5

Loc. All from olive shale of Mapan stage at Mapanshan, Chingchiachengtzu, Fuchouhsien, Liaoning.

Elrathia chuwaensis KOBAYASHI forma *rinsonica*, n. f. ..... p. 47

Figure 9. Early holaspid of this species (?), ×3 (Loc. C 3/1).

Figure 10. Early holaspid, ×3. (Loc. R 52).

Loc. Rinson shale of Chunghwa area, (SAITO's collection).

Amecephalus saitoi KOBAYASHI, new species ..... p. 51

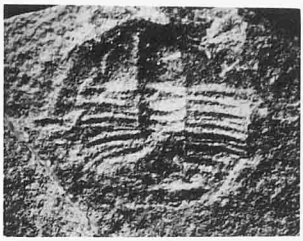
Figures 11a-b. Holotype cranidium and its clay-cast, ×2. Loc. North of Chunghwa; Rinson shale (SAITO collection, loc. D_1).

Elrathia cfr. *hoboi* RESSER and ENDO ..... p. 49

Figure 12. Complete dorsal shield, ×4. Loc. Dark gray shale of probably Mapan stage in Chingchiachengtzu, Liaoning. (Old institute collection).

Ptychoparia orientalis RESSER and ENDO ..... p. 43

Figure 13. Nearly Imperfect complete dorsal shield, ×3. Loc. Shihchiaoan reddish shale at Peihsüehmei (北雪梅), east of Liaoyang, Liaoning.



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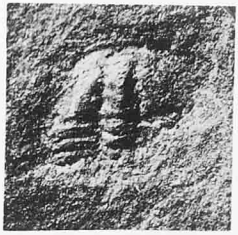

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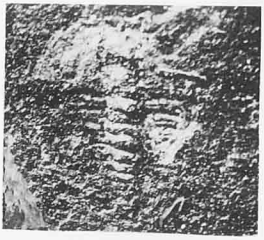

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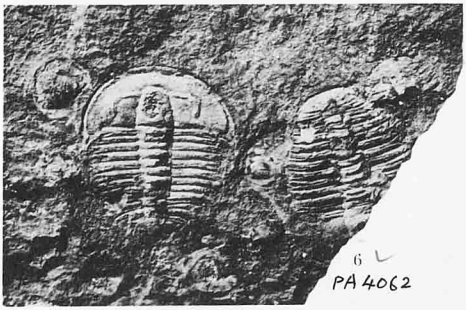

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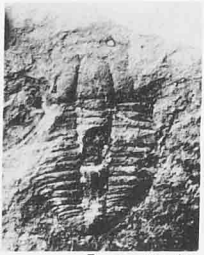

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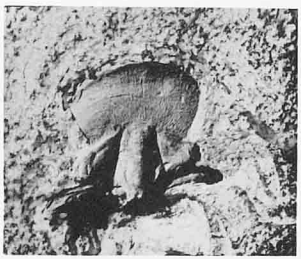

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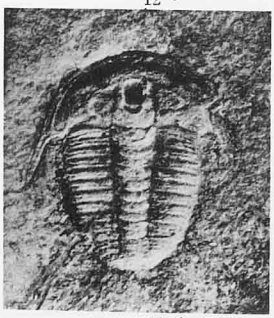

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Explanation of Plate XII

Hundwarella (*Honanaspis*) *matsushitai* KOBAYASHI, new species ..... p. 95

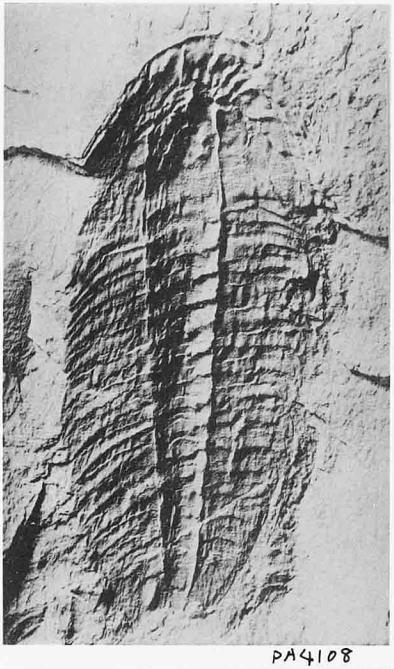
Figures 1a-b. Dorsal and ventral impressions of the holotype shield, ×3. Loc. Tangshihan chocolate shale of Chinchou loc. 4.

Proasaphiscus huoliensis ENDO ..... p. 98

Figure 2. Imperfect dorsal shield and hypostoma, ×3. Loc. Tangshihan chocolate shale at Tangshihling, southeast of Yentai, Liaoning. (OZAWA collection)

Proasaphiscus yabei RESSER and ENDO ..... p. 98

Figure 3. Complete dorsal shield and impression of hypostoma, ×3. Loc. Tangshihan chocolate shale at Hueiyao, near Yentai, Liaoning.



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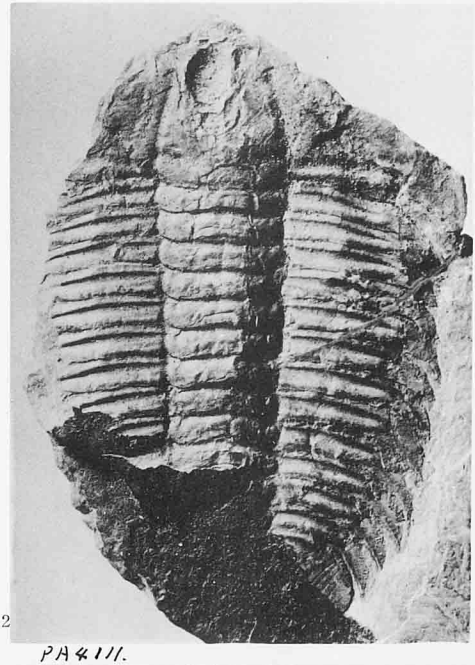

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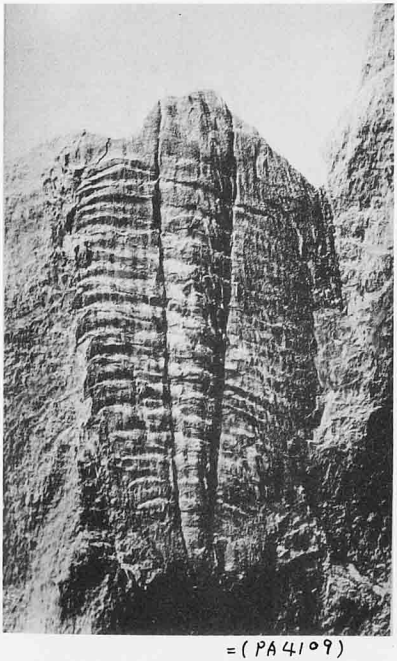

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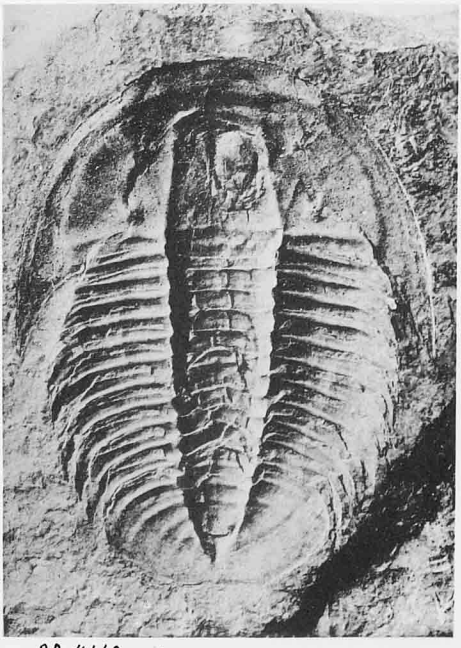

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