DOI:10.19800/j.cnki.aps.1959.03.004

NEW TRILOBITES FROM THE MIDDLE CAMBRIAN OF NORTH CHINA

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The present paper deals with six new genera, one new subgenus, twenty new species and three new varieties of trilobite found from the Middle Cambrian formations of North China. Most of them were once enlisted in the writer's foregoing paper (Chang, 1957), in which a brief account of the stratigraphic sequence has been given. It now seems desirable to describe those new forms for further reference.

Genus *Luia* Chang (gen. nov.), 1957

Genotype: *Luia typica* Chang (sp. nov.), 1957

1957. *Luia* Chang, Acta Palaeontologica Sinica, Vol. 5, No. 1. p.

Diagnosis: Opisthoparian trilobite with dorsal shield elliptical in outline, parapygous to isopygous. Cephalon semicircular. Dorsal furrow narrow, glabella broadly conical, rounded in front, with three or four pairs of glabellar furrow; occipital ring slightly broader in the middle, occipital furrow broad and shallow; occipital ring slightly broader in the middle, occipital furrow broad and shallow; palpebral lobe small, convex; eye ridge oblique and slightly elevated. Fixed cheek slightly convex and narrow, posterior lateral limb strong, transversely extended and a little shorter than the width of the glabella at its base; posterior lateral furrow shallow and broad. Brim narrow, a little longer than the greatest width of the front border. Area of both the brim and the front of the eye ridge ornamented with fine reticulate lines radially arranged. Anterior course of facial suture divergent in front of the palpebral lobe at first, then convergent when it marching across the marginal furrow. Posterior course of facial suture slightly oblique outward with a short distance, then transversely oblique with a longer distance. Free cheek broad, also ornamented with reticulate lines, genal spine relatively short.

Thorax composed of no less than 8 thoracic segments. Axial lobe narrower than that of the pleural lobe. Pleural spine stout and short.

Pygidium large, semi-circular to semi-elliptical; axial lobe convex, tapering gradually backward, with 5—8 axial rings; pleural lobe with 4—6 broad and shallow furrows. Border flat and relatively narrow.

Remarks: So far as the writer is aware that *Luia* is intimately related to Walcott's *Anomocarella* in the shape and the size of dorsal shield and pygidium, but it is easily distinguished from the lectotype cranidium of *Anomocarella* refigured by Endo and Resser in 1937 in its less broader cranidium, broad conical glabella, well marked glabellar furrows, small palpebral lobe, narrower fixed cheek, broader brim and presence of reticulate lines in front of the glabella and eye ridges.

It also differs from *Asaphiscus* in its broad conical glabella, three or four pairs of glabellar furrows, relatively small palpebral lobe and presence of genal spine.

It is also interesting to note that *Maladiodella* Endo, 1937 resembles *Luia* in the general outline of the cranidium, but *Maladiodella* differs from *Luia* in its truncato-conical glabella and its pygidium.

It seems unfortunate that no less than 8 thoracic segments of this genus are known. We know that two near complete specimens of *Anomocarella* have been described and figured by Kobayashi (1943) in which one shows 10 thoracic segments, while the other has 11 thoracic segments. The genotype of *Asaphiscus*, i.e., *A. wheeleri* Meek, has 9 thoracic segments. Most Chinese species which have formerly been referred to *Asaphiscus* by Endo & Resser (1937, *A. walcotti*, *A. bassleri*) have 11 thoracic segments and should belong to *Liaoyangaspis*. Although it is difficult to know the actual number of the thoracic segments of this genus, the writer is inclined to believe that *Luia* is intimately related to *Anomocarellidae* Hupe, 1953.

Horizon and locality: *Fuchouia-Luia* subzone of the Changhsia formation, Poshan, Shantung.

Luia typica Chang (sp. nov.)

(Pl. I, figs. 1—4; text-fig. 1)

1957. *Luia typica* Chang, Acta Palaeontologica Sinica, Vol. 5, No. 1, pl. 1, fig. (3) 1; 2.

Glabella slightly convex, cylindroconical, broadly rounded in front, four pairs of glabellar furrows; first and second pairs short, shallow, broad, and obliquely upward; third pair relatively long, shallow, broad, and obliquely downward; fourth pair longer, deep and somewhat obliquely downward bended. Occipital ring slightly convex, a little broader in the middle; occipital furrow shallow and broad. Dorsal furrow very narrow. Palpebral lobe narrow, convex, short and slightly curved outwards. Palpebral furrow shallow and narrow. Eye ridge convex, oblique and narrow. Fixed cheek relatively narrow, about 1/3 the width of the middle part of the glabella. Postero-lateral limb strong, transversely extended and a little shorter than the greatest width of the glabella; postero-lateral furrow very shallow and broad. Brim narrow, flat and a little longer than the greatest width of the frontal border. Marginal furrow narrow and shallow. Border slightly convex, broader in the middle and laterally gradually narrower. Area of both the brim and the front of the eyeridges ornamented with fine reticulate lines. Anterior course of facial suture divergent (divergent suture with an angle of ca. 30° with the axis) in front of the palpebral lobe at first, then convergent when it marching across the marginal furrow; posterior course of facial suture slightly oblique outward with a short distance, then transversely oblique with a longer distance.

thorax unknown.

Pygidium flat, semi-elliptical in outline; axial lobe narrow, slightly convex, tapering gradually backward, with faint axial rings; pleural lobe with 4—6 broad, shallow furrows, border narrow.

Horizon and locality: *Fuchouia-Luia* subzone of the Changhsia formation, Poshan, Shantung.

Cat. No. 9284—9287. Field No. C4.

Luia yaochiayuensis Chang (sp. nov.)

(Pl. I, figs. 5—7)

Cranidium broad. Glabella short, broad and rounded in front; four pairs of faint and shallow glabellar furrows, fourth pair somewhat bifurcate. Anterior course of facial suture more divergent, with an angle of ca. 45° with the axis; posterior course obliquely transverse.

A fragmental specimen of the thorax with its pygidium attached probably referred to this species reveals that it is composed of no less than 8 thoracic segments; its axial lobe is narrower than the pleural lobe, its pleural furrow is shallow and broad; pleural spine is stout and short.

Pygidium broadly semi-circular, axial lobe narrow, tapering gradually backward, with 6—8

rings; pleural lobe subtriangular, with 5—7 broad and shallow pleural furrows, interpleural furrows faint and obscure, border narrow and flat.

Remarks: This species resembles closely *L. typica* in many aspects, but it differs chiefly in its broad cranidium and glabella, more divergent anterior suture, short and semi-circular pygidium.

Horizon andlocality: Same as the preceding.

Cat. Nos. 9288—9290. Field No. C4.

Luia shantungensis Chang (sp. nov.)

(Pl. I, fig. 8)

This differs from the preceding two in its contracted cranidium and slightly contracted glabella and its posterior projection behind the front border.

Horizon and locality: Same as the preceding.

Cat. No. 9291. Field No. C4.

Genus *Metanomocarella* Chang (gen. nov.)

Genotype: *Metanomocarella rectangula* Chang (sp. nov.)

Diagnosis: Cranidium convex, dorsal furrow narrow and deep, glabella convex, oblong, glabellar furrows more or less present, variant in depth; fixed cheek narrow, convex, about 1/3 the width of the glabella. Occipital ring convex, broad in the middle; occipital furrow narrow and deep. Palpebral lobe convex, eye ridge well defined, oblique and a little narrower than that of the palpebral lobe. Brim very convex and narrow. Anterior border convex, tumid and thickened backward in the middle to form a stout projection. Antero-lateral border also convex, but very narrow. Marginal furrow broad and deep, curved backward to meet without the dorsal furrow. Postero-lateral limb relatively long and strong, postero-lateral furrow deep and narrow. Anterior facial suture subparallel, posterior course oblique outward and backward.

Pygidium convex, semicircular in outline. Axial lobe with four rings, convex, stout; pleural lobe with two or three furrows, convex. Border relatively narrow.

Horizon and locality: Taitzu Formation, Shuangmiaotzu, Liaoyang, Liaotung Province; *Crepicephalina* zone of Changhsia formation, Poshan, Shantung.

Remarks: Compared with *Anomocarella* this new genus differs in several variant features, particularly in the oblong glabella, convex and tumid frontal border, narrow and convex brim, deep dorsal furrows, broad and deep marginal furrows, deep occipital furrow and posterior lateral furrows and narrow fixed cheeks, etc. It is evident that Anomocarella has glabella with parallel sides, all furrows on the cranidium shallow, flat border and wider fixed cheeks.

As the writer is aware that most *Anomocarella* has more or less large pygidium with relatively narrow and conical axis, and with faint and broad furrows on both the axis and the pleural lobes. While most specimens of pygidium found in association with the cranidium of *Metanomocarella* seem proportionately a little smaller than that of *Anomocarella*, and it is also a fact that stout axial lobe with four rings is very conspicuous.

The genus *Metanomocarella* is distinguished also from *Aojia* Resser and Endo by the oblong glabella, the convex and thickened border, convex and narrow brim, absence of stout occipital spine and absence of lateral spines on the pygidium.

Metanomocarella rectangula Chang (sp. nov.)

(Pl. I, figs. 9—12; Text-fig. 2)

Cranidium convex, dorsal furrow narrow and deep. Glabella rectangular; four pairs of glabellar

furrows; first pair narrow, short and oblique upward; second pair narrow, relatively longer than the first and also oblique upward; third pair broad, shallow and tending to bifurcate in its inner ends; fourth pair very broad, shallow, and bifurcate. Occipital ring convex, broad in the middle, occipital furrow narrow and deep. Palpebral lobe convex; eye ridge well defined, narrow and confluently joined with antero-lateral part of the glabella. Fixed cheek more convex, and about 1/3 the width of the glabella. Postero-lateral limb strong, postero-lateral furrow very deep and relatively broad. Brim convex and very narrow, area in front of the eye ridge sloping abruptly downward. Border convex, tumid and thickened backward in the middle to form a stout projection, and narrow gradually toward its both extremities. Marginal furrow broad and deep. Anterior course of facial suture short and subparallel, posterior course oblique outward and backward.

Pygidium relatively small, semicircular in outline, stout axial lobe with four rings, pleural lobe relatively narrow and with three incurved furrows.

Remarks: This species resembles closely *Metanomocarella tumida*, but it differs chiefly in its well defined glabellar furrows.

In 1937 Endo described *Aojia tumida* from the Taitzu formation near Shuangmiaotzu, 7.5 miles east of Liaoyang, Liaotung province (Endo & Resser, 1937, p. 175, pl. 47, figs. 6—7). The cranidium and its associated pygidium are quite distinct from those of *Aojia* in the absence of the lateral pygidial spines and in the convex and thickened border in front of the glabella. Although some new materials referred to the same species later described and figured by Endo (Endo, 1944, pl. I, figs. 15—16; Pl. II, figs. 1—4), unfortunately, its illustrations are obscure and its description is brief. Judging from Endo's obscure illustrations, those specimens of this species still differ from *Aojia* in the tumid border and absence of the stout and long occipital spine. On account of the presence of some young forms associated with the present new species in our materials, the writer is inclined to refer Endo's 1937 *Aojia tumid* to be immature specimens of *Metanomocarella tumida* (Endo) (1944) or any species of this new genus *Metanomocarella*.

Horizon and locality: *Crepicephalina* zone, Changhsia formation, Poshan, Shantung. Cat. Nos. 9292—9295. Field No. C5.

Genus *Prodamesella* Chang (gen. nov.)

Genotype: *Prodamesella convexa* Chang (sp. nov,)

1957. *Prodamesella* Chang, Acta Palaeontologica Sinica, Vol. 5, No. 1.

Diagnosis: Cranidium convex, broadly trapezoidal in outline. Dorsal furrow deep. Glabella truncato-conical, three pairs of short and deep glabellar furrows. Palpebral lobe small, eye ridge convex, stout and transverse. Fixed cheek very broad. Postero-lateral limb large and stout. Brim absent. Border flat, broad and slightly reflected upward, its outer margin with a very narrow elevation. Marginal furrow shallow and broad. Anterior course of facial suture short, subparallel to slightly convergent; posterior course rounded outward and backward. Surface marked by fine pits. Free cheeks, thorax and pygidium unknown.

Remarks: Although this new genus is represented only by one imperfect cranidium, the writer is convinced that this fragmental cranidium should be referred to a new genus. Because it differs either from *Damesella* or from *Blackwelderia* in its broad cranidium, characteristic glabella and glabellar furrows, prominent and transverse eye ridge, very small palpebral lobes, characteristic frontal border and very stout and short posterior lateral limb.

It should be noted that in 1937 and 1944, Endo described two species, *Damesella quadrata* (1937, pl. 49, fig. 32) and *Olenoides manchuriensis* (1944, pl. 4, figs. 8—9) from the Middle Cambrian of Liaotung province, of which the former has a more quadrilateral glabella, well marked gla-

bellar furrows, convex fixed cheek, relatively depressed preglabellar area, a deep dorsal furrow along the sides of glabella and a narrow frontal border. While the latter has a transversely broad cranidium, a rectangular glabella, glabellar furrows, broader fixed cheeks, more transversely stretched eye ridges. With regard to *Olenoides manchuriensis*, Endo has compared with *Olenoides asiaticus* Kobayashi, 1935. The writer considers that the detached cranidium and pygidium which has been referred to *Olenoides* by Endo, by no means belong to this genus because it has rectangular glabella, broad fixed cheeks and smooth pygidium, etc.

Insofar as the writer is aware that Endo's *D. quadrata* and *O. manchuriensis* resemble closely *Prodamesella* in the general outline of the cranidium, glabella and transversely stretched eye ridges, etc., the writer would tentatively and provisionally assigns to *Prodamesella* two species described by Endo as *D. quadrata* and *Olenoides manchuriensis*.

Prodamesella convexa Chang (sp. nov.)

(Pl. I, fig. 13; Text-figs. 3—4)

The characteristic features have already been mentioned in the diagnosis of this genus.

Horizon and locality: *Mapania* zone of the Changhsia formation, Poshan, Shantung, Cat. No. 9296. Field No. C17.

Genus *Liaoyangaspis* Chang (gen. nov.)

Genotype: *Asaphiscus bassleri* Resser et Endo, 1937

1957. *Liaoyangaspis* Chang, Acta Palaeontologica Sinica, Vol. 5, No. 1.

Diagnosis: Dorsal shield elliptically ovate in outline, cephalon semi-circular, genal spines present, thorax with same length of the cephalon (or a little longer than); pygidium semi-circular or semi-elliptical in outline, a little shorter than the length of the cephalon.

Cranidium convex, glabella conical, glabellar furrows obscure. Occipital furrow shallow and narrow, occipital ring relatively narrow. Fixed cheek convex. Palpebral lobe convex, with medium size. Eye ridge well developed. Posterior lateral limb long, posterior lateral furrow narrow. Brim broad. Anterior course of facial suture slightly divergent, posterior course long and transversally outward.

Thorax composed of eleven thoracic segments. Axial lobe narrower than the width of the pleural lobe. Pleural spine short.

Pygidium only slightly shorter than that of the cephalon, axial lobe narrow, tapering gradually backward, rounded in its posterior end. Pleural lobe subtriangular in outline; border broad, segmentation of pygidium indistinct.

Remarks: In 1944 Endo convinced that his *Asphiscus kobayashii* figured in pl. 49, figs. 15, 16 (Resser et Endo, 1937) unquestionably belong to *A. bassleri*. Therefore the type species of this new genus should be *Asaphiscus bassleri*.

In 1911, Walcott assigned to the genus *Asaphiscus* one species, *A. iddingsi* found from Changhsiang Island, Liaotung province, but in 1937 Resser and Endo added 7 new species to this genus. Walcott's species resembles *Asaphiscus wheeleri* in the number of the thoracic segments, and general outline of the glabella, it differs from *Asaphiscus* in its genal spines, narrow brim and narrow postero-lateral limb, longer pleural spines of the thorax and relatively smaller segmentated pygidium. While those species described by Resser and Endo are prominently different from *Asaphiscus* in its conical glabella, narrow and long postero-lateral limbs, presence of genal spines and 11 thoracic segments. We know that *Asaphiscus* is a well known genus and that its genotype is *A. wheeleri*

Meek. According to its photography illustrated in pl. 258, fig. 9 in the Index Fossils of N. America (1944), *A. wheeleri* has a broadly semiovate glabella, stout and shorter postero-lateral limbs, absence of genal spines, 9 thoracic segments and a semi-circular pygidium. From the foregoing account, it appears clear that the great majority of those species which have been referred to *Asaphiscus* by Resser and Endo, are of the oriental forms, and should be referred to the new genus *Liaoyangaspis*.

It should be noted that *Asaphiscus suni* Resser et Endo and *Asaphiscus transversus* Resser et Endo are quite different from *A. bassleri*, *A. walcotti*, *A. peiensis*, *A. tsutsumii*, etc. in the glabella, facial suture and form of pygidium. *A. suni* has a parallel sided glabella, broadly rounded in front, glabellar furrows, very narrow brim, more oblique anterior suture, large palpebral lobe and segmentated pygidium, while *A. transversus* has truncato-conical glabella, narrow border, anterior divergent suture and narrow brim. Therefore *suni* and *transversus* should belong to other genera rather than *Liaoyangaspis*.

As discussed in the preceding paragraph 4 species listed are valid:

1. *Liaoyangaspis bassleri* (Resser et Endo), 1937
2. *Liaoyangaspis walcotti* (Resser et Endo), 1937
3. *Liaoyangaspis peiensis* (Resser et Endo), 1937
4. *Liaoyangaspis tsutsumii* (Endo), 1937.

Liaoyangaspis bassleri (Resser et Endo)

(Pl. II, figs. 1—3; Text-figs. 5—6)

1937. *Asaphiscus bassleri* Resser et Endo, "Man. Sci. Mus." Bull. 1, p. 180, pl. 43, figs. 1—4.
1937. *Asaphiscus kokayashii* Resser et Endo, ibid, p. 181, pl. 49, figs. 15—16.
1944. *Asaphiscus bassleri* Resser et Endo, "Bull. Cent. Nat. Mus. Manchou Kuo" p. 84.
1957. *Liaoyangaspis kobayashii* (Resser et Endo), Chang, Acta Palaeontologica Sinica, vol. 5, no. 1, pl. I, fig. (3) 3.

Dorsal shield elliptical oval in outline; cephalon a little shorter than thorax, while pygidium a little shorter than that of the cephalon; axial lobe narrow.

Cephalon semicircular, with genal angles extended backward into short spines. Cranidium gently convex. Glabella conical, smooth, well defined by narrow dorsal furrows. Glabellar furrows obscure. Occipital ring narrow; occipital furrow narrow and shallow. Fixed cheek convex, with moderate width. Palpebral lobe of medium size, eye ridge convex, well defined and slightly oblique. Postero-lateral limb relatively narrow and long, postero-lateral furrow also narrow. Brim slightly depressed and as broad as the width of the anterior border (or a little broader than the border). Border flat, broad and slightly thickened in front of the glabella. Anterior course of facial suture slightly divergent, posterior course transversally outward. Free cheek as broad as the fixed cheek.

Thorax composed of 11 segments, axial lobe narrower than the width of the pleural lobe (ratio ca. 2:3), pleural spine short, pleural furrow distinct.

Pygidium semicircular, axial lobe narrow, pleural lobe subtriangular in outline, segmentation of the pygidium indistinct.

Remarks: Reseer and Endo have compared this species with that of *Asaphiscus walcotti*, and they stated that: "The general outline of this species is similar to that of *A. walcotti*, but it has a narrower frontal limb and rim, more conical glabella, fewer thoracic segments, and a peculiar axis in the pygidium, which serve to distinguish it. The present species has 10 thorax segments instead of 11, ..."

With regard to the number of the thoracic segments, Resser and Endo believed that it has

10 instead of 11, but it is a fact that the only one complete specimen referred to this species and illustrated in pl. 43, fig. 1 shows really 11 thoracic segments. The writer does not know why Resser and Endo miscounted the number of the thoracic segments of this species for which they have owned the type-specimen.

Horizon and locality: *Liaoyangaspis bassleri* zone of Changhsia formation, Poshan, Shantung and Liaotung provinces.

Cat. Nos. 9297—9299. Field No. C9, C13.

Liaoyangaspis walcotti (Resser et Endo)

(Text-fig. 7)

1937. *Asaphiscus walcotti* Resser et Endo, "Man. Sci. Mus." Bull. 1, p. 180, pl. 43, fig. 5.

It differs from the preceding in its broad brim, broad free cheek, prominent and relatively longer pleural spines of the thorax, and more divergent anterior facial suture.

Liaoyangaspis endoi (sp. nov.)

(Text-fig. 8)

1937. *Asaphiscus walcotti* Resser et Endo, "Man. Sci. Mus." Bull. 1, p. 180, pl. 43, fig. 6.

Dorsal shield broadly ovate, glabella broadly conical, pleural lobe of the thorax more broader than that of its axial lobe. Pygidium short, transversally broad, axial lobe short, border broad.

Liaoyangaspis wangi (sp. nov.)

(Text-fig. 9)

1957. *Asaphiscus walcotti* Resser et Endo, Lu, Index Fossils of China, Vol. 3, pl. 142, fig. 5.

Dorsal shield elongately ovate, Glabella elongately conical, free cheek slightly broader than fixed cheek. Pygidium semi-elliptical, both axial lobe and pleural lobes faintly segmentated.

Liaoyangaspis tsutsumii (Endo)

(Text-fig. 10)

1937. *Asaphiscus tsutsumii* Endo, "Man. Sci. Mus." Bull. 1, p. 350, pl. 60, figs. 19—20.

Cranidium transversally broad, glabella broadly conical, fixed cheek broad, postero-lateral limb stout and short. Anterior suture subparallel to slightly divergent. Pleural spines of the thorax indistinct. Pygidium semi-elliptical.

Genus *Poshania* Chang (gen. nov.) 1957

Genotype: *Poshania poshanensis* Chang 1957

1957. *Poshania* Chang, Acta Palaeontologica Sinica, Vol. 5, no. 1.

Diagnosis: Parapygous to isopygous trilobite of medium size. Cranidium subquadrate or subtrapezoidal in outline, test with very fine pits. Glabella rectangular with sides slightly expanded backward; glabellar furrows faint. Occipital ring convex, narrow at the sides, occipital furrow with moderate depth. Fixed cheek more convex, narrower than that of the glabella. Palpebral lobe of medium size, convex and central; eye ridge slightly oblique, narrow, convex and arisen directly from the frontal lobe of the glabella. Postero-lateral limb strong, postero-lateral furrow very deep. Border convex, slightly arched forward and broad in the middle. Marginal furrow curved forward to meet dorsal furrow. Brim absent; a narrow and transverse convex ridge lain in the anterior dorsal furrow. Anterior course of facial suture divergent, posterior course oblique backward. Free cheek large, extending posteriorly into a long and inward curved genal spine; broad furrow on the genal spine and confluently meeting the marginal furrow.

Number of the thoracic segments unknown, pleural furrow broad. Pygidium short, transversely broad. Axial lobe strongly convex, conical, composed of 6 axial rings. Pleural lobe fused, four pleural furrows and four interpleural furrows retained. Border broad and flat, marginal furrow faint.

Remarks: *Poshania* is a peculiar Middle Cambrian genus so far as its pre-glabellar features and its pygidium. It can be compared with many trilobite genera viz. *Namanoia* Lermontova, 1951, *Ordosia* Lu, 1954, *Taitzuia* Resser et Endo, 1935, *Inouyella* Resser et Endo, 1935, *Inouyina* Poletayeva, 1936, *Levisia* Walcott, 1911, and *Peichiashania* Chang, 1957, etc. They represent certainly a special group that well developed in Siberia and Eastern Asia in the Cambrian period. The characteristic features common in both genera are the marginal furrow joining confluently with the anterior dorsal furrow in front of the glabella and rectangular glabella. The pygidia of some genera e.g. *Namanoia, Ordosia, Taitzuia* and *Poshania* have well furrowed axial lobe and pleural lobes with pleural and interpleural furrows and rounded entire margin. While the pygidia of the other genera remain unknown. Therefore the writer intends to unit those genera under the same family, and the writer thinks that Lermontova's *Namanoidae* should be considered becaused it has the priority.

Namanoia is the only Lower Cambrian genus of Eastern Siberia. In that genus two formae *longa* and *lata* under the species *N. namanensis* have been described by Lermontova. In which *longa* has a subrectangular glabella with faint glabellar furrows; the thickened border in front of the glabella is not so much depressed and the confluence of the two curved marginal furrows with the anterior dorsal furrow comes near to the middle line of the glabella. While *lata* has parallel sided glabella, less curved and more uniform marginal furrow. The pygidium subsemicircular to subtriangular, its axial lobe less conical as compared with that of *Poshania* and composed of 5 axial rings, its border depressed and very narrow.

In 1954, Lu described *Ordosia* from the limestone slabs in the upper part of the Kushan formation at Shihtsingkou of Siwamen, Yuantzewan and Tayuyaotze, Tsingshuiho, Inner Mongolia. The cranidium of this genus is subquadrate in outline; its anterior border is convex and relatively narrow; the confluence of the marginal furrows with the anterior dorsal furrow in front of the glabella is broad and much depressed. The anterior course of the facial suture is subparallel and a short median occipital spine is present. Also many characteristic features seen in the pygidium are the semi-elliptical outline, highly convex axial lobe with 7—8 rings, strongly elevated broad marginal border and a very deep and broad marginal furrow.

In 1937, Resser and Endo described two new Middle Cambrian trilobite genera *Inouyella* and *Taitzuia*. The former differs from *Poshania* in its reflected, flat and subtriangular brim, very narrow anterior marginal border, anterior convergent suture and truncato-conical glabella. The pygidium illustrated in pl. 46, figs. 11—12 (Resser et Endo, 1937) referred to this genus is quite different from the pygidium of *Poshania* in the few furrows on the pleural lobe and in the absence of interpleural furrow, but the writer wonders, as well as Resser and Endo, whether it really belongs to this genus. While the latter which is based on an imperfect cranidium, certainly resembles *Poshania* in the cranidial features, but it differs from this genus in the broad, reflected anterior border and less curved marginal furrow.

It should be noted that Resser and Endo did not recognize what is the pygidium of their *Taitzuia*. But judging from the materials found from Poshan and Chiawang, the writer recognized that its pygidium has a subsemicircular outline, strongly convex axial lobe with 7 axial rings, pleural lobe with 4—5 segments, interpleural furrows present and a very narrow

border. The present writer also convinced that the pygidium illustrated in pl. 47, fig. 2 (Resser et Endo, 1937), which has been referred to *Aojia longispina* Resser et Endo, should be a pygidium actually belonging to *Taitzuia,* and is also certainly different from the pygidium of *Poshania.*

It is quite interesting to note that *Inouyina* is more similar to *Taitzuia* than any other genera discussed in the foregoing paragraph. The anterior broad border, its marginal furrow, its anterior dorsal furrow, glabella, eye ridge and palpebral lobe quite resemble *Taitzuia.* It differs from *Taitzuia* only in its four pairs of glabellar furrows, but it is a fact that many cranidia in hand can safely be referred to *Taitzuia* and have glabellar furrows with different strength. Therefore it seems highly probable that *Inouyina* is synonymous with *Taitzuia.*

The genus *Levisia* resembles closely *Taitzuia* and *Inouyina,* rather than *Poshania.* It differs from the three in having a strongly convex cranidium, tumid and globular glabella and slightly convergent anterior facial suture. The distribution of *Levisia* which is found in association with *Taitzuia* in the late Middle Cambrian of North China is very interesting. It is well known to occur in Changhsia, Shantung, and has lately been found in association with *Taitzuia* in Chengshan, southern Chiawang district, Northern Kiangsu province. So far as the writer is aware, there is no record of its occurrence in other places of North China.

In 1957, based upon *Eymekops rectangularis* Resser et Endo (1937, pl. 68, fig. 21), the writer erected a new genus *Peichiashania,* because Resser and Endo's species is quite different from *Eymekops hermias* (Walcott), the genotype of *Eymekops. Peichiashania* has proportionately a longer cranidium, longer rectangular glabella, large palpebral lobe, relatively short postero-lateral limb and relatively narrow frontal border. According to Endo, it occurs from the Daizan formation at Peichiashan, Fuchouhsien, Liaotung Province, and it perhaps may be a derivative from either *Poshania* or *Taitzuia.*

Attention is also called to *Chelidonocephalus* from the uppermost of the Middle Cambrian of Iran (King, 1937), as in this genus the preglabellar area reveals two transverse furrows, in which the upper one as its marginal furrow, while the lower curved downward and confluently joined the anterior dorsal furrow in front of the glabella. The occipital ring and posterior lateral limbs are narrow.

Finally, it is certain that *Poshania, Taitzuia,* etc. bear a striking resemblance to *Damesella,* especially to *D. brevicaudata* in the general outline of the cranidium, glabella, palpebral lobes and in the features of the preglabellar area. But the latter differs in having six or seven pairs of pygidial spines.

Horizon and locality: *Taitzuia-Poshania* zone of the Changhsia formation, Poshan, Shantung.

Poshania poshanensis Chang (sp. noo.)

(Pl. II, figs. 4—10; Text-fig. 21)

1957. *Poshania poshanensis* Chang, Acta Palaeontologica Sinica, Vol. 5, No. 1, pl. 1, fig. (3) 4.

Cranidium convex, subquadrate or subtrapezoidal in outline. Glabella rectangular, slightly tapering forward; glabellar furrows faint. Occipital ring convex, broad in the middle, gradually narrow toward its both extremities. Occipital furrow relatively narrow. Fixed cheek strongly convex, narrower than the glabella. Palpebral lobe of medium size, convex; eye ridge convex, narrow, slightly oblique, arisen from the frontal lobe of the glabella. Postero-lateral limb strong; postero-lateral furrow deep. Brim absent. Border convex, thickened in the middle, gradually

narrow toward both sides. Marginal furrow broad and deep, curved downward and confluently joined anterior dorsal furrow in front of the glabella. A narrow ridge lain transversely in the anterior dorsal furrow. Area in front of the eye ridges convex. Anterior course of facial suture divergent; posterior course oblique outward and backward. Surface often with very fine pits. Free cheek broad and convex; genal spine long and bending inward, broad marginal furrow extending to the genal spine.

Thorax unknown.

Pygidium convex, short, transversely broad; axial lobe conical, strongly elevated with 6 axial rings (including the terminal lobe); pleural lobe subtriangular, sloping posteriorly and laterally towards its border, with 5 segments displaying 5 broad pleural furrows and 4 relatively shallow and narrow interpleural furrows. Border broad and flat.

Horizon and locality: *Taitzuia-Poshania* zone of the Changhsia formation, Poshan, Shantung.

Cat. Nos. 9300—9306. Field No. C21.

Poshania transversa Chang (sp. nov.)

(Pl. II, figs. 11—13; Text-fig. 20)

This differs from the preceding in the broader cranidium, truncato-conical glabella with four pairs of glabellar furrows, absence of the transverse narrow ridge in front of the glabella, presence of the oblique and rectangular area between the thickened border and the glabella.

The axial lobe of the pygidium of this species broad, its terminal lobe broadly rounded, axial rings, pleural furrows and interpleural furrows on the pleural lobe of the pygidium more distinct.

Horizon and locality: Same as the preceding.

Cat. Nos. 9307—9309. Field No. C21.

Poshania sp. (sp. nov.)

(Pl. II, fig. 14)

This species is represented only by a crushed cranidium. It differs from the preceding two chiefly in having an elongately truncato-conical glabella, five or six pairs of faint glabellar furrows, gently sloping thickened border in front of the glabella, and a very small tubercle on the occipital ring.

Horizon and locality: Same as the preceding.

Cat. No. 9310. Field No. C21.

Genus *Taitzuia* Reeser, et Endo in Kobayashi, 1935

Taitzuia quadrata Chang (sp. nov.)

(Pl. IV, figs. 17, 18)

Cranidium convex, quadratic in outline. Glabella convex, truncato-conical or broadly conical, rounded in front, and marked by three or four pairs of glabellar furrows, The first and second pairs faint, shallow and oblique upward, third and fourth pairs broad, very shallow, and somewhat bifurcate. Occipital furrow shallow, occipital ring ocnvex, narrow, broad in the middle, and provided with a medium node. Palpebral lobe strongly convex, about one-third the length of the glabella. Eye ridge elevated, narrower than palpebral lobe, arisen confluently from the frontal lobe of the glabella, and extending obliquely. Fixed cheek more convex, measured across the

palpebral lobe a little narrower than one-third the width of the glabella. Brim absent. Boreder gently convex and broad. Marginal furrow confluently joined with the anterior dorsal furrow in which a very narrow and transverse ridge found. Anterior course of facial suture subparallel to very slightly divergent from the palpebral lobe. Fixed cheek, areas in front of the eye ridges and the glabella with the exception of the glabellar furrows granulated.

Pygidium subsemicircular in outline, strongly convex. Axial lobe more convex, elevated above the pleural lobes, tapered backward, divided by 6 axial rings in which the posterior one steeply elevated above the posterior margin. Pleural lobe subtriangular, convex, marked by 5 pleural furrows and 4—5 interpleural furrows.

Bemarks: Some twelve species have been referred to this genus as listed below:

Yenchou formation (Upper Cambrian)

1. *Taitzuia triangulata* Endo, 1937

Changhsia formation (=Taitzu formation) (Middle Cambrian)

2. *Taitzuia insueta* Endo et Resser, 1935
3. *Taitzuia abderus* (Walcott), 1905
4. *Taitzuia acanthus* (Walcott), 1905
5. *Taitzuia acerius* (Walcott), 1905
6. *Taitzuia acidalia* (Walcott), 1905
7. *Taitzuia acis* (Walcott), 1905
8. *Taitzuia admeta* (Walcott), 1905
9. *Taitzuia agave* (Walcott), 1905
10. *Taitzuia adrastia* (Walcott), 1905
11. *Taitzuia puteata* (Endo), 1937
12. *Taitzuia granulata* Endo, 1944
13. *Taitzuia liaotungensis* Endo, 1944
14. *Taitzuia glabella* Endo, 1944

The first species found from the Yenchou formation in Liaotung province belongs questionably to *Taitzuia*, because the cranidial feature of this fragmental cranidium is quite distinct from *Taitzuia*, and because *Taitzuia* is a Middle Cambrian genus. With regard to this species the writer can express no opinion more.

The second species is the type of the genus which is the best known. In a later revision of the Chinese Cambrian trilobites described by the late C. D. Walcott (1913), Resser made eight species (3—10) referred to *Taitzuia*. In which the specimens of those species of 3, 4, 5, 7, 8, and 9 as shown by Walcott on his pl. 16 (Walcott, 1913) are too fragmentary to say anything definite. Although they resemble closely *Taitzuia*, little is known of their specific concept.

Taitzuia acidalia (Walcott) which is based on an imperfact cranidium perhaps may be a valid species referred to this genus, because its frontal border, glabella, dorsal and marginal furrows are more or less defined.

Taitzuia adrastia (Walcott) disagrees with any species referred to *Taitzuia* in its globular glabella. In the writer's opinion this species as shown in text-figs. 18, 19 of this paper is still valid under the genus *Levisia*. But it should be noted that there is a slight difference between the two cranidia, on which Walcott's *Levisia adrastia* is based. The former, the type specimen of this species (Walcott, 1913, fig. 5, on pl. 16) has a globular glabella with a few scattered larger granules, and broken frontal border and postero-lateral limb, while the latter (Walcott, 1913, pl. 16, fig. 5a) has a smooth and globose glabella, and broken left fixed cheek.

The writer quite agrees with Kobayashi in transferring Endo's *Damesella puteata* (Endo et Resser, 1937, pl. 60, fig. 13) from *Damesella* to *Taitzuia*, because its broad frontal border is different from *Damesella*.

The illustrations of *Taitzuia liaotungensis* Endo and *Taitzuia glabella* Endo (Endo, 1944, pl. 7, fig. 2; pl. 7, figs. 5—8) are obscure. *Taitzuia granulata* Endo (Endo, 1944, pl. 7, figs. 3—4) with square glabella, narrower fixed cheeks, and narrower, slightly rearward projection of the frontal border, is quite distinct from *Taitzuia*. Probably it represents a separate new genus.

From the foregoing account the writer considers that the following four are valid:—

Taitzuia insueta Endo et Resser, 1935
Taitzuia acidalia (Walcott), 1905
Taitzuia puteata (Endo), 1937
Taitzuia quadrata Chang (sp. nov.)

Horizon and locality: *Taitzuia-Poshania* zone of the Changhsia formation, Poshan, Shangtung.

Cat. Nos. 9342—9344. Field No. C21.

Genus *Proasaphiscus* Resser et Endo, in Kobayashi, 1935

Subgenus *Honanaspis* Chang (subgen. nov.)

Subgenotype: *Honanaspis honanensis* Chang (sp. nov.)

Diagnosis: Dorsal shield elongately ovate in outline. Cephalon semi-circular; genal spine short. Thorax longer than that of cephalon and pygidium. Pygidium short and about one-half to one-third the length of the cephalon.

Cranidium gently convex, dorsal furrow shallow and narrow, glabella rectangular, slightly tapering forward, three or four pairs of faint glabellar furrows. Occipital furrow narrow with moderate depth, occipital ring relatively narrow and slightly broad in the middle. Fixed cheek relatively narrow, about one-half to one-third the width of the glabella. Palpebral lobe gently convex, relatively shorter than that of *Proasaphiscus yabei*. Palpebral furrow shallow and narrow. Eye ridge well defined and slightly elevated. Postero-lateral limb long; its length being almost equal with the greatest width of the glabella. Postero-lateral furrow narrow and shallow. Brim gently convex, with the same width (or a little broader than) as the anterior border. Anterior border very slightly convex or flat. Anterior course of facial suture slightly divergent, posterior course oblique and transverse. Free cheek slightly broader than the fixed cheek, and produced backward into a short genal spine.

Thorax composed of 13 thoracic segments, its axial lobe narrower than that of the pleural lobe. Pleural spine short when compared with that of *Proasaphiscus yabei*. Pygidium also smaller than *Proasaphiscus yabei*.

Remarks: The present new subgenus *Honanaspis* agrees well with *Proasaphiscus yabei*, the genotype of this genus found from Liaotung province by Endo.

The main distinction of this new subgenus from *Proasaphiscus* is in the relatively short palpebral lobe, 13 thoracic segments, shorter pleural spines of the thorax and relatively small pygidium. We know that *Proasaphiscus yabei* has a relatively large palpebral lobe, 11 thoracic segments, longer pleural spines and larger pygidium. With regard to the number of the thoracic segments of *P. yabei*, it shows fairly well eleven thoracic segments on the dorsal shield of this species in Resser and Endo's Pl. 41, figs. 17, 18, 20 and 21. The writer does not understand why Resser and Endo miscounted the number of the thoracic segments when they described the type species of their new genus. It is a fact that this species is actually composed of eleven thoracic segments, and it is evident

that more fairly well preserved specimens of this species have lately been found in Liaotung Province by Lu, Wang and others. (Text-fig. 23).

It is interesting to note that *Elrathia kingi* (Meek) is very similar to *Honanaspis* in the cranidium, free cheek, 13 thoracic segments and relatively small pygidium. However, the former differs from the latter in the rounded frontal lobe of the glabella, relatively small palpebral lobe, broader brim, more longer postero-lateral limb, relatively narrower axial lobe of the thorax and narrower border of the pygidium. Judging from the larval and adult specimens of *Honanaspis* in hand, the present writer is inclined to believe that *Honanaspis*, *Proasaphiscus* and Ptychoparids are allied to each other, and that the former is probably derived from the ptychoparids of early Middle Cambrian or late Lower Cambrian age.

So far as the writer is aware that Resser and Endo's *Manchuriella* is intimately related to *Proasaphiscus* and is ill-defined because the type specimens selected by Endo and Resser are too fragmentary to give a more exact concept of this genus. Since the erection of *Proasaphiscus* and *Manchuriella*, so many species have been referred to them by Endo, Resser and Kobayashi, and some confusion between them has been made. From the foregoing account the writer thinks *Manchuriella* is perhaps no more than a subgenus of *Proasaphiscus*.

On the other hand, it should not be overlooked that Mansuy (1916) has described two species *Conokephalina termieri* Mansuy and *C. tienfongensis* Mansuy from the Middle Cambrian in the border land between Yunnan and Haut-Tonkin. In a later study on the trilobites from the above mentioned locality, Kobayashi (1944) put them into *Hundwarella* which has also been designated as a subgenus to *Manchuriella* by the same author. But the writer believes that Mansuy's two species are very similar to *Proasaphiscus* rather than *Manchuriella* in the oblong glabella, eye ridge, palpebral lobe and facial suture. The main distinction of *Conokephalina termieri* and *C. tienfongensis* from *Proasaphiscus* or *Honanaspis* is in the 12 thoracic segments. From what has been said above, it is evident that Mansuy's two species perhaps represent the link between *Proasaphiscus* and *Honanaspis* for it has just the intermediate number of the thoracic segments. If Mansuy's two species really belong to *Hundwarella**, the present writer intends to refer it as a subgenus to *Proasaphiscus*.

Horizon and locality: *Bailiella* zone of the Hsuchuan formation (always a few metres below the *Bailiella* level), Liaotung, Shantung and Honan Provinces.

Proasaphiscus (*Honanaspis*) *honanensis* Chang(sp. nov.)

(Pl. III, figs. 1—4; Text-fig. 24)

Dorsal shield gently convex, elongately ovate; cephalon semicircular. Cranidium gently convex, dorsal furrow narrow. Glabella truncato-conical or rectangular in outline, marked by four pairs of glabellar furrows, the first pair short and extending obliquely upward; second pair also short, horizontally extending or very slightly upward; third pair long and backward oblique; fourth pair longest, oblique backward and bifurcated. Occipital furrow narrow, occipital ring very slightly broad in the middle. Palpebral lobe gently convex, with about one-half the length of the glabella (excluding occipital ring), eye ridge narrow, elevated and slightly oblique. Fixed cheek measured across the palpebral lobes a little narrower (or equal to) than one-half the width of the glabella. Postero-lateral limb as long as the width of the glabella, postero-lateral furrow prominent and

* In the writer's opinion *Hundwarella* is quite distinct from Mansuy's two species in the glabella, glabellar furrows, occipital ring, broader brim, more curved palpebral lobe, narrow postero-lateral limb and narrow border. Therefore, it seems necessary to erect a new subgeneric name under *Proasaphiscus* for *Conokephalina termieri* Mansuy and *C. tienfongensis* Mansuy.

transverse. Brim gently convex, as broad as the width of frontal Border. Border flat or gently convex, broad in the middle, gradually narrower toward both extremities. Anterior course of facial suture slightly divergent, posterior course transversely oblique.

Thorax composed of 13 thoracic segments; axial lobe narrow and tapering gradually backward; pleural lobe broad; pleural furrow broad and deep; interpleural furrow narrow and shallow; pleural spine short.

Pygidium small, subsemicircular in outline; axial lobe broad, convex and with 6 faint rings; pleural lobe triangular, with 4—5 pleural furrows; interpleural furrow faint and very shallow. Border flat, narrow behind the posterior end of the axial lobe, gradually broad in the antero-lateral corner. A very small and very faint spine situated a little behind antero-lateral corner. With regard to this faint spine, the writer recognizes that it is quite similar to the pygidium of *Anomocare laeve* Angelin illustrated by Walcott in 1913, on pl. 18, fig. 16.

Horizon and locality: *Bailiella* zone of the Hsuchuan formation, Laofengkou, Sungpiao, Honan Province.

Cat. No. 9311—9314. Field No. F5.

Coll. Field Party of the Geological Bureau of Petroleum, Ministry of Geology, People's Republic of China.

Proasaphiscus (*Honanaspis*) *lui* Chang (sp. nov.)

(Pl. III, figs. 5—6; Text-fig. 25)

1957. *Proasaphiscus lui* Chang, Preliminary note on the Lower and Middle Cambrian Stratigraphy of Poshan, Central Shantung, Acta Palaeontologica, Sinica, Vol. 5, No. 1, p. 16 & 30.

Dorsal shield moderately convex, elongately ovate; cephalon semicircular. Cranidium gently convex, dorsal furrow narrow. Glabella truncato-conical, marked by three pairs of broad, shallow and faint glabellar furrows. Occipital furrow narrow and very shallow, occipital ring slightly broad in the middle. Palpebral lobe narrow, gently convex, about one-third the length of the glabella (excluding the occipital ring); eye ridge narrow, slightly elevated and oblique; palpebral furrow narrow and shallow. Fixed cheek gently convex, measured across the palpebral lobe a little narrower (or equal to) than one-third the width of the glabella. Postero-lateral limb strong, a little shorter than the greatest width of the glabella; postero-lateral furrow shallow and narrow. Brim gently convex, as broad as the width of the frontal border. Border slightly convex, broad in the middle, gradually narrower toward both extremities. Anterior course of facial suture slightly divergent, posterior course transversely oblique. Free cheek a little broader than the fixed cheek, its border narrow and produced backward into a short genal spine.

Thorax composed of 13 thoracic segments; axial lobe narrow and tapering gradually backward; pleural lobe broad; pleural furrow deep; interpleural furrow narrow and shallow. Pleural spine short.

Pygidium small, transversely broad; axial lobe tapering rapidly backward, with 5—6 faint rings; pleural lobe triangular, incurved by faint furrows; border flat, narrow behind the posterior end of the axial lobe, gradually broad in the antero-lateral corner.

Remarks: This species which is named in honor of Prof. Y. H. Lu, agrees fairly with the preceding. But it differs in having a broad, truncato-conical glabella; three pairs of broad, shallow and faint glabellar furrows; relatively shorter palpebral lobe; broad postero-lateral limb and transversely broad pygidium.

Horizon and locality: *Bailiella* zone of the Hsuchuan formation (few meters below the *Bailiella* cf. *lantenoisi* level), Yaochiayu, Poshan, Shantung.

Cat. No. 9315—9316. Field No. C7.

Proasaphiscus (*Honanaspis*) *machidai* (Endo)

1937. *Proasaphiscus machidai* Endo. The Sinian and Cambrian formations and fossils of southern "Manchoukuo", "Mahchurian Sci. Mus." Bull. 1, p. 352, pl. 59, fig. 15; pl. 60, figs. 22, 23.

This species can safely be referred to this subgenus because it has a ractangular glabella, relatively small palpebral lobe and 13 thoracic segments. It resembles closely *P.* (*Honanaspis*) *honanensis* in the cranidium, but it differs in its broad cranidium, the short rectangular glabella, relatively small palpebral lobe, broad frontal border, larger pygidium and very short axial lobe of the pygidium. It also differs from *P.* (*Honanaspis*) *lui* in its short rectangular glabella, broad cranidium, broad frontal border and its larger pygidium.

Horizon and locality: Bailiella zone of the Tangshih formation, Liaotung Province.

Genus *Szeaspis* Chang (Gen. nov.)

Genotype: *Szeaspis reticulatus* Chang (sp. nov.)

Diagnosis: Dorsal shield oval in outline, gently convex. Cephalon semicircular. Cranidium moderately convex, glabella conical, broadly rounded in front, marked by three pairs of faint glabella furrows. Palpebral lobe narrow, convex and more curved outward, palpebral furrow deep. Brim gently convex, and with medium width, when the cranidium is weathered, it always shows reticulate sculpture in front of the glabella and the eye ridges. Border broad, often produced rearward into a small projection in the middle, narrow at both extremities. Anterior course of facial suture first divergent from the palpebral lobe, then convergent and cutting the outer margin at a distance about one-third the length of the frontal border. Posterior course transverse and cutting the posterior margin within the genal angle.

Thorax composed of 9 thoracic segments. Pleural spine long. Pygidium subsemicircular. Axial lobe conical, with a conical posterior axial ridge. Border broad, 4—5 pleural furrows running across it to the margin.

Remarks: This differs from *Asaphiscus* in having conical glabella, large and more curved palpebral lobes, narrow and long postero-lateral limbs, presence of long genal spines, narrow axis of the dorsal carapace, longer pleural spines of the thorax and relatively small and furrowed pygidium. It differs also from *Proasaphiscus* and *Honanaspis* in its broadly rounded anterior end of the glabella, large and more curved palpebral lobes, deep palpebral furrow, nine, instead of eleven, or thirteen segments in the thorax, and relatively larger pygidium.

Attention is also called to *Anomocare laeve* Angelin (Walcott, 1911, pl. 17, figs. 1a—c; 1913, pl. 18, figs. 1, 1a—b), the type species of *Anomocare* from the Middle Cambrian *Paradoxides forchhammeri* zone of Sweden, as in this genus the glabella is truncato-conical. Brim is more broad, narrow border is reflected upward, palpebral lobe is more narrow and long, postero-lateral limb seems short and narrow, posterior course of facial suture seen on the free cheek is short, genal spine is also short and slender, axial lobe of the pygidium seems less conical and the presence of very small lateral spine is attached to both antero-lateral margins of the pygidium.

So far as the writer knows that this genus is widely distributed in the argillaceous limestones and yellowish green shales of the Middle Cambrian in North China. But it should be pointed out that specimens referred to this genus and preserved in argillaceous limestones always shows clear furrows on both the cephalon and the pygidium, while the specimens found from the green shales shows faint furrows and less convex shield.

Many species which have been referred to *Fuchouia*, *Manchuriella*, *Proasaphiscus* and *Asaphiscus* by Endo, Resser and Walcott now become *Szeaspis*.

1. *Szeaspis pustulosa* (Endo et Resser) (Endo et Resser, 1937, pl. 36, fig. 13).
2. *Szeaspis centronatus* (Endo et Resser) (Endo et Resser, 1937, pl. 37, figs. 17, 20).
3. *Szeaspis* sp. (Endo et Resser, 1937, pl. 39, fig. 4, free cheek, not pygidium).
4. *Szeaspis iddingsi* (Walcott) (Walcott, 1911, pl. 16, fig. 3; Walcott, 1913, pl. 23, fig. 1; Resser et Endo, 1937, pl. 41, fig. 22).
5. *Szeaspis*(?) *offula* (Endo et Resser) (Endo et Resser, 1937, pl. 46, fig. 30).

This new genus is named in honor of Prof. H. C. Sze.

Szeaspis reticulatus Chang (sp. nov.)

(Pl. III, figs. 11—16)

1957. *Asaphiscus* cf. *iddingsi* Walcott, Chang. Preliminary note on the Lower and Middle Cambrian Stratigraphy of Poshan, Central Shantung. Acta Palaeontologica Sinica, Vol. 5, No. 1, p. 15, 30.

Cranidium gently convex. Dorsal furrow narrow. Glabella convex, conical, rounded in front, marked by three pairs of faint glabellar furrows. Occipital furrow narrow, occipital ring convex, almost with equal width, and curved slightly rearward. Palpebral lobe relatively long and more curved outward; palpebral furrow broad and deep; eye ridge convex, and slightly oblique. Fixed cheek moderately convex, about one-third the width of the glabella. Postero-lateral limb long and narrow; postero-lateral furrow deep and narrow. Brim gently convex, as broad as the width of the border (or a littlt broader than the width). When the shield is exfoliated, reticulate sculptures become fairly well defined. Border flat, or gently convex, with a small and rear projection in the middle, broad in the middle and gradually narrower toward both ends. Marginal furrow narrow and deep, row of small pits situated along the bottom of this furrow. Anterior course of facial suture divergent from the palpebral lobes (divergent facial suture with an angle of ca. 30—35° with the axis) at first, then convergent when it running across the marginal furrow (convergent suture with an angle of ca. 50—60° with the axis), and cutting the outer margin at a distance about one-third the length of the cranidial border. Posterior course more tranverse.

Pygidium gently convex, subsemicircular to subrectangular. Axial lobe more conical, convex, and divided into one articulating half ring and 4 or 5 axial rings. A narrow, conical and convex ridge situated behind the terminal lobe of the axis. Pleural lobe narrow, subtriangular and marked by five broad pleural furrows which ended in pits just inside of the doublure (or the border,) and then running across those pits, gradually shallow and scarcely perceptible in front of the posterior margin. Border broad, a little narrower and situated behind the axial lobe, and broader in the antero-lateral parts.

Horizon and locality: *Fuchouia-luia* subzone of the Changhsia formation, Poshan, Shantung.

Cat. No. 9317—9321. Field No. C4.

Szeaspis reticulatus var. *brevicus* Chang (var. nov.)

(Pl. III, figs. 7—10)

Dorsal shield oval in outline. Cephalon semicircular. Cranidium gently convex, transversely broad. Glabella broadly conical, short, rounded in front and marked by three pairs of very faint glabellar furrows. Occipital furrow narrow, occipital ring gently convex. Palpebral lobe more curved outward, palpebral furrow deep and broad. Eye ridge convex and short. Fixed cheek

moderately convex, about one-third the width of the glabella. Postero-lateral limb narrow and transverse; postero-lateral furrow narrow and deep. Brim with reticulate sculpture, gently convex, as broad as the width of the border. Border convex or flat, broad in the middle, narrow at its lateral ends. Marginal furrow with small pits, narrow and deep. Anterior course of facial suture more divergent from tht eye (divergent suture with an angle of ca. 50—60° with axis), then more convergent when it running across the marginal furrow. Posterior course more transverse and slightly oblique. Free cheek as broad as the fixed cheek, also with reticulate lines radially arranged. Its border broad and very flat. Genal spine long, flat and stout.

Thorax composed of 9 thoracic segments; axial lobe narrower than the pleural lobe; pleural furrow shallow and broad, pleural spine long and pointed outward and rearward.

Pygidium semicircular, and transversely broader than that of the preceding.

Horizon and locality: Same as the preceding.

Cat. No. 9322—9325. Field No. C4.

Genus *Tonkinella* Mansuy, 1916

Tonkinella shantungensis Chang (sp. nov.)

(Pl. IV, fig. 1)

1957. *Tonkinella shantungensis* Chang. Preliminary note on the Lower and Middle Cambrian Stratigraphy of Poshan, Central Shantung. Acta Palaeontologica Sinica, Vol. 5, No. 1, pl. 1, fig. 1.

This species is represented only by one pygidium, nothing is as yet known about the cephalon and thorax of this species.

Pygidium convex, subsemicircular in outline. Axial lobe more convex, narrow, about one-half the width of the pleural lobe and about one-third the length of the pygidium, tapering gradually backward, divided into five axial rings, its terminal ring broadly rounded. Articulating half ring faintly preserved and narrow. Pleurae composed of 12 radial lobes, articulating half segment also narrow.

Remarks: The pygidia of *Tonkienlla flabelliformis* and *T. shantungensis* are very much alike, but the former differs from the latter in its shorter axial lobe and 11 radial lobes on the pleurae. *T. stephensis* and *T. breviceps* differ from our species in the six axial rings of the axial lobe and 13 radial lobes on the pleurae.

Horizon and locality: This species occurs in the *Metagraulos abrota* zone of the Hsuchuan formation in Poshan district. Recently Lu has informed the writer that some specimens of *Tonkinella* have also been found in his collections from the *Metagraulos abrota* zone of the Tangshih formation in Liaotung Province. Well preserved specimens of *Tonkinella* and *Metagraulos* have also been discovered by L. I. Igorova from Paofeng and Lushan, western Honan Province.

The occurrence of *Tonkinella* in North China is very important because the complete Cambrian succession, especially the Middle and Upper Cambrian of eastern Asia is well developed in North China (or Sino-Korean Platform), and its exact stratigraphical position is ascertained. On account of the presence of this genus in the Hsuchuan formation (or Tangshih formation), it is possible that the Hsuchuan formation not only represents the early Middle Cambrian of eastern Asia, but may also be correlated with the early Middle Cambrian faunal zones of North America.

Cat. No. 9326. Field No. C8.

Genus *Koptura* Resser et Endo, in Kobayashi, 1935

Koptura longibiloba Chang (sp. nov.)

(Pl. IV, fig. 2)

This species is represented by a pygidium.

Pygidium less convex. Axial lobe relatively short, narrow, more convex, slightly tapering backward, rounded in its posterior end and composed of 5 rings. Articulating half ring convex, narrow. Posterior axial ridge faint and conical. Posterior margin very strongly sinuated, pleural lobes produced backward into two long and large lobes. 4 pleural furrows and 3 faint and narrow interpleural furrows on each pleural lobe, both furrows extending from the axial furrow a little outward at first, then abruptly backward.

Remarks: *Koptura longibiloba* is distinguished from *Koptura lisani* (Walcott) and *K. biloba* by its short and less conical axial lobe of the pygidium, more longer two lobes and presence of the interpleural furrows.

Horizon and locality: *Crepicephalina* zone of the Changhsia formation, Poshan, Shantung. Cat. No. 9327. Field No. C11.

Genus *Crepicephalina* Resser et Endo, in Kobayashi, 1935

Crepicephalina damia var. *rectangula* Chang (var. nov.)

(Pl, IV, figs. 3, 4)

The pygidium of this variety resembles closely the pygidium of *Crepicephalina damia* (Walcott) in the rectangular outline, stout pygidial spines, 5 faint rings of the axial lobe and three oblique furrows on each pleural lobe. But it differs chiefly from the latter in its short axial lobe of the pygidium, relatively smaller size of the pygidium, broader fixed cheek, broader frontal border of the cranidium and faint glabellar furrows.

Horizon and locality: *Crepicephalina* zone of the Changhsia formation, Poshan, Shantung. Cat. No. 9329, Field No. C12, C11.

Genus *Damesella* Walcott, 1905

Damesella bilongispina Chang (sp. nov.)

(Pl. IV, fig. 5)

Pygidium convex. Axial lobe more convex, narrower than the pleural lobe, subconical, rounded at the posterior, and divided into one articulating half ring, five ordinary axial rings and one short terminal lobe which abruptly elevated above the other rings. Pleural lobe also convex, and incurved by 5 broad pleural furrows. Six pairs of pygidial spines, first and fifth pairs of pygidial spines longer than the remaining four on the pygidium. Sixth pair short and stout. Margin behind the axial lobe sinuated.

Remarks: It is very interesting to note that although this species is represented only by one pygidium, there are no pygidium of this genus which can be compared with. *D. brevicaudata* Walcott has first and fifth pairs of longer pygidial spines, but it has seven pairs of pygidial spines.

While comparing this pygidium with other pygidia referred to *Damesella* and *Blackwelderia*, the writer noted that there are variant in the number of the pygidial spines between those species of *Damesella* and *Blackwelderia*, and that most species of *Damesella* have six, or seven pairs of pygidial spines, while species of *Blackwelderia* often with seven to eight pairs of pygidial spines.

As a result of recent investigation made by Lu and the writer, we know that *Damesella* is always stratigraphically below *Blackwelderia* which is a genus characterized in the *Drepanura* zone and *Blackwelderia* zone of the Kushan formation. *Damesella octaspina* Kobayashi which is identical with *Blackwelderia octaspina* Resser et Endo, has eight pairs of pygidial spines and widely distributed in the *Drepanura* zone in Eastern Asia. *Damesella bilongispina* with six pairs of pygidial spines found from *Peishania* zone of the Changhsia formation probably represent a forerunner of this genus. From the foregoing account, with regard to this group of trilobite, the present writer has the concept that the higher they occur, the more pygidial spines they have, and that whether it shows a phylogenetic tendency between those spinose trilobites. The writer believes that the increase of the number of the pygidial spines perhaps indicates the decrease in the number of the thoracic segment. But it is a fact that except *Damesella paronai* (Airaghi) which has six pairs of pygidial spines and 12 thoracic segments, little is known of the number of the thoracic segment of those species referred to *Damesella* and *Blackwelderia**. Therefore the writer

Faunal zones	No. of Pairs of Pygidial Spines	Species
Drepanura zone	8	"*Damesella*" *octaspina* Kobayashi, 1935 (=*Blackwelderia octaspina* Endo et Resser, 1937)
	8	*Blackwelderia octaspina* Endo et Resser, 1937
	7	*Blackwelderia paronai* (Airaghi)
	7	*Blackwelderia sinensis* (Bergeron)
Blackwelderia zone	7	*Parablackwelderia spectabilis* (Endo et Resser), 1937
	7	*Blackwelderia biloba* Kobayashi
	7	*Blackwelderia paronai* Walcott
	7	*Blackwelderia sinensis* (Bergeron)
Damesella zone	7	*Damesella brvicauda* Walcott
	7	*Damesella bella* Endo et Resser, 1937
	7	*Damesella nitida* Endo et Resser, 1937
	7	*Damesella damesi* Endo et Resser, 1937 (= *Damesella brevicauda* Walcott, Kobayashi 1941)
	6	*Damesella paronai* (Airaghi)
	?6	*Damesella liaotungensis* Endo et Resser, 1937
	?6	*Damesella conica* Endo et Resser, 1937
	6	*Damesella* sp. Endo et Resser, 1937 (Pl. 45, fig 9)
	6	*Damesella walcotti* Endo et Resser (= *Damesella paronai* (Airaghi), Kobayashi, 1941)
	6 spines	*Damesella manchuriensis* Endo et Resser, 1937 (= *Damesella paronai* (Airaghi), Kobayashi, 1941)
Peishania zone	6	*Damesella bilongispina* Chang

*It is uncertain, however, whether the strongly enrolled dorsal shield illustrated by Kobayashi (1942) in figs. 1—8 on pl. XX really belongs to *Blackwelderia sinensis* (Bergeron) or not. As in Kobayashi's specimen, the marginal border of the pygidium is practically undefined, the pleurae are clearly defined by narrow interpleural furrows, and the pygidial spines certainly and confluently coincide with the pleural spines. In the writer's opinion Kobayashi's specimen resembles closely *Stephanocare richthofeni* Monke (Kobayashi, 1941, pl. III, upper and lower figures) rather than *Blackwelderia*.

hopes that it is valuable to search in the future time for complete specimens of *Damesella* and *Blackwelderia* in both the Changhsia and Kushan formations, and that the present conception of some of the problems concerned may direct the efforts of future investigations to their solution.

The preceding table shows the stratigraphical range and the number of the pairs of pygidial spines of most species of *Blackwelderia* and *Damesella,* of which the pygidia have been recognized.

It should be noted that some species of *Damesella* with six pairs of pygidial spines survive in the *Blackwelderia* zone, but no species of *Damesella* found from the *Drepanura* zone.

Horizon and locality: *Peishania* zone of the Changhsia formation, Poshan, Shantung.
Cat. No. 9330. Field No. C22.

Genus *Peishania* Resser et Endo, in Kobayashi, 1935

Peishania lubrica Chang (sp. nov.)

(Pl. IV, figs. 7—10)

1957. *Peishania lubrica* Chang, Preliminary note on the Lower and Middle Cambrian Stratigraphy of Poshan, Central Shantung. Acta Palaeontologica Sinica, Vol. 5, No. 1, Pl. 1, fig. 2.

Cranidium highly convex, subrectangular or subquadrate in outline. Glabella more convex, conical, rounded in front, glabellar furrows obscure. Dorsal furrow very shallow. Occipital furrow shallow and indistinct, when the test is exfoliated, it may become fairly well defined. Occipital ring convex, broad in the middle and very narrow at its lateral ends. Palpebral lobe small, eye ridge obscure. Fixed cheek convex, measured across the palpebral lobe about one-third the width of the glabella. Postero-lateral limb short and stout, postero-lateral furrow shallow. Brim sloping forward and narrow. Border flat, broader than the brim. Anterior course of facial sutures subparallel to each other. Posterior course backward oblique. Surface smooth.

Pygidium convex, semicircular in outline. Axial lobe convex, tapering slightly backward, rounded in its posterior end, composed of one articulating half ring and 5—6 ordinary axial rings. Pleural lobe triangular, with faint pleural furrow and interpleural furrows, merging postero-laterally and smoothly into broad, smooth and gently convex border.

Remarks: This species agrees fairly with *Peishania affinis* Resser et Endo in the cranidial features, however, it differs from the latter in its less distinct dorsal furrow, marginal furrow and occipital furrow. It differs also from *Peishania convexa* in its broad, flat border and shallow and indistinct marginal furrow.

Horizon and locality: *Peishania* zone of the Changhsia formation, Poshan, Shantung.
Cat. No. 9332—9336. Field No. C22, C24.

Peishania lubrica var. *peitalingensis* Chang (var. nov.)

(Pl. IV, fig. 6)

This differs from the preceding chiefly in its more broad and flat frontal border. When the test is exfoliated, three pairs of glabellar furrows are clearly defined, and the third pair is bifurcated.

Horizon and locality: Same as the preceding.
Cat. No. 9331. Field No. C22.

Genus *Fuchouia* Endo et Resser, in Kobayashi, 1935

Fuchouia spinosa Chang (sp. nov.)

(Pl. IV, figs. 12—16; Text-figs. 26—27)

Cranidium subtrapezoidal in outline. Glabella convex, rectangular, rounded in front and with two pairs of oblique glabellar furrows. Occipital furrow broad and shallow. Occipital ring broad in the middle and produced backward into a short occipital spine. Palpebral lobe narrow, convex and about one-third the length of the glabella (excluding the occipital furrow and ring); eye ridge very short and indistinct; palpebral furrow narrow. Fixed cheek gently convex, narrow, measured across the palpebral lobes a little narrower than one-third the width of the glabella. Postero-lateral limb longer than the greatest width of the glabella, with a small intergenal spine attached to its lateral end; postero-lateral furrow shallow and broad. Brim absent. Border narrow and slightly reflected upward. Marginal furrow narrow and shallow. Anterior course of facial suture short, somewhat divergent from the palpebral lobe; posterior course long and transversely oblique. Free cheek broad, gently convex, its border narrow and produced backward into a short and slender genal spine.

Pygidium subsemicircular in outline. Axial lobe convex, conical, elevated above the pleural lobes, and composed of one articulating half ring and 5—6 ordinary axial rings, if the axial lobe has 6 axial rings, the posterior articulating furrow is always deep, narrow and detached. Pleural lobe more or less flat, subtriangular and with five deep pleural furrows which end in pits just inside of the doublure. Interpleural furrows narrow, shallow, faint and extending diagonally between pleural furrows. Two or three pairs of short and small pygidial spines are often clearly preserved in the antero-lateral margin. The anterior pair of pygidial spine relatively longer and large, the second pair very short and less prominent, while the posterior pair often faint and obscure, in some well preserved specimens it always shows a small swelling margin opposite the pitted end of the third pleural furrow.

Another interesting specimen of a pygidium (pl. 4, fig. 15) shows large and stout anterior pair of pygidial spine, because the anterior segment of the pleural lobe does not firmly tie with the next segment in the lateral end. It is questionable whether this phenomena really shows the evolutional tendency of the reduction of the number of the thoracic segments in some trilobites, or it shows an abnormal development of this specimen.

Remarks: This species agrees fairly with *Fuchouia manchuriensis* (Walcott), the type species of this genus, but it is easily distinguished by its two or three pairs of small pygidial spines. Although some specimens with intergenal spine referred to *F. manchuriensis* were also illustrated by Kobayashi (1942, pl. 1, figs. 12—19), two pygidia (Kobayashi, 1942, pl. 1, figs. 18—19) are also without short lateral spines. *Fuchouia chiai* Lu (Lu 1957, pl. 140, figs. 11, 12) which is a species found from the Middle Cambrian in eastern Kueichou Province, southern China, has a rectangular glabella slightly expanded between the anterior end of eye ridges, relatively short postero-lateral limb, absence of intergenal spine and pygidial spines. From which this new species is also distinguished.

Horizon and locality: *Fuchouia-Luia* subzone of the Changhsia formation, Poshan, Shantung.

Cat. No. 9337—9341. Field No. C4.

Genus *Inouyia* Walcott, 1911

Inouyia fongfongensis Chang (sp. nov.)

(Pl. IV, fig. 19)

1957. *Inouyellaspis fongfongensis* Chang. Preliminary note on the Lower and Middle Cambrian Stratigraphy of Poshan, Shantung. Acta Palaeontologica Sinica, Vol. 5, No. 1, p. 30.

Cranidium convex, semielliptical in outline. Glabella convex, truncato-conical, about one-half the length of the cranidium, and marked by three pairs of short, faintly impressed glabellar furrows. Occipital furrow shallow and narrow; occipital ring broad in the middle. Palpebral lobe small; eye ridge faint and oblique. Fixed cheek strongly convex, a little narrower than the width of the glabella. Postero-lateral limb narrow, postero-lateral furrow narrow, and with moderate depth. Brim absent. Border strongly convex, very broad, semicircularly arched forward, and tumid in the middle as a prominent boss or swelling in front of the glabella; both extremities of the border narrow and sharpened. Marginal furrow very broad and shallow. Anterior course of facial suture seems subparallel to slightly divergent. Posterior course unknown.

Remarks: This species is similar to *Inouyellaspis expectans* Ivshin in the general outline of the cranidium and glabella, it differs from the latter in its preglabellar boss and its narrow occipital ring. It differs also from *Inouyia melie* (Walcott) (Walcott, 1913, pl. 14, fig. 12) in its semielliptical outline of the cranidium.

Horizon and locality: Upper part of the Hsuchuan formation, Fongfong coal field, Southern Hopei Province.

Cat. No. 9344.

图 版 I 說 明

1—4 *Luia typica* Chang (新属、新种)
1. 头盖;放大2倍,正型标本(9284)。
2. 头盖;原大(9285)。
3. 尾部;原大(9286)。
4. 尾部;放大2倍(9287)。

5—7 *Luia yaochiayuensis* Chang (新种)
5. 头盖;放大1.5倍,正型标本(9288)。
6. 胸部及尾部,放大1.5倍(9289)。
7. 尾部;放大2倍(9290)。

8 *Luia shantungensis* Chang (新种)
8. 头盖;放大2倍(9291)。

9—12 *Metanomocarella rectangula* Chang (新属、新种)
9. 尾部;放大3倍(9292)。
10. 尾部;放大5倍(9293)。
11. 头盖;放大5倍(9294)。
12. 头盖;放大3倍,正型标本(9295)。

13 *Prodamesella convexa* Chang (新属、新种)
13. 头盖;放大10倍,正型标本(9296)。