Genus *Maotunia* nov.

**Type species:** *Maotunia semiplectra* gen. et sp. nov.

**Diagnosis:** Proasaphiscid genus with only partial or very early development of a plectrum, with prominent anteromedian node on the occipital ring, with a pit laterally in the 1P furrow, with narrow fixed cheeks and an arcuate palpebral lobe near the posterior part of the glabella, with a pair of depressions laterally in the preglabellar furrow. Thorax with eleven segments having spinose pleural tips curved posteriorly. Pygidium relatively large, semicircular, with pleural and interpleural furrows, with relatively narrow axis and narrow border, often with a slight posteromedian indentation.

**Discussion:** This group of species from the early part of the Changhian and latest part of the Hsuchuangian in northern China is distinctive in their glabellar furrows, and pygidium but they seem most important in that they almost certainly include the ancestors of *Mapania* and of the Anomocarellidae. There is slight difference between the pygidia of these two genera, and the major distinction is in the trapezoidal cranidium and the plectrum of *Mapania* and *Maotunia*, respectively.

It should be noted that *Anomocareta angustum* Whitehouse, 1939 which was referred to as *Mapania angusta* by Opik (1961, p. 167) belongs to *Maotunia* having the typical weak, incomplete development of the plectrum, the longer brim, tapering glabella, four pairs of lateral glabellar furrows, pleural and interpleural pygidial furrows and narrow pygidial border of that genus. Opik's reconstruction (1961, fig. 55) is not accurate in the degree of development of the plectrum or in the omission of a 4P lateral glabellar furrow. Furthermore the single specimen referred to *Mapaniidae gen. nov. et sp. nov.* by Opik (1967, p. 304, pl. 23, fig. 2) almost certainly belongs to *Maotunia* also, the occipital and glabellar furrows, plectrum and palpebral lobes are all typical.

As already pointed out *Maotunia* probably gave rise to *Mapania* and the Anomocarellidae during the early and middle Changhian in China but survived in Australia later than in China. Judging from the characteristics of the cephalon, thorax and pygidium of *Maotunia*, we provisionally refer this genus to the family Proasaphiscidae.

**Occurrence:** Changhian Stage, China and Australia.
Maotunia semiplectra sp. nov.

(Plate 82, figures 1—4; plate 83, figure 1; plate 84, figure 1)

Etymology: Semi-Latin prefix meaning “half” or “part of”. The name alludes to the incomplete or very early development of a plectrum.

Holotype: IGP 76411, the complete specimen (less free cheeks) figured below (pl. 82, figs 1, 2).

Diagnosis: Member or Maotunia with a very short brim, only weakly developed plectrum, convex glabella with parallel sides truncated anterior and rounded anterolateral corners, and twelve thoracic segments. Pygidium large with narrow border slightly indented posteromedially, with axis finishing forward of the inner edge of the doublure.

Description: Moderately sized species with elongate oval outline having slightly broader curvature anteriorly. The exoskeleton is moderately convex especially in the lateral profile of the glabella, and posterior profile of thorax and pygidium.

Cranidium weakly convex in anterior and lateral profile. Glabella parallel-sided to slightly tapering forward with rounded anterolateral corners and a transverse truncated central anterior margin. Four pairs of lateral glabellar furrows are evident on exfoliated specimens but on those retaining the exoskeleton furrow 3P is not visible. Furrow 1P is forked adaxially and has a lateral pit-like deeper part. Furrow 4P is low at the axial furrow and is directly opposite the centre of the eye ridge. In some specimens lobes 1P and 3P seem wider than 2P but this is variable and only a very small difference. The axial furrow is well impressed and has two deeper parts anterior to the glabella laterally. The occipital furrow is well impressed, deepest and shortest laterally and has a faint anterior convexity axially in some specimens. The occipital ring is long axially, tapers laterally and bears a prominent anteromedian spine. The brim is short and a plectrum is variably developed although it is seldom as distinct as in Mapania. The anterior border is short and very weakly convex but in exfoliated specimens it appears longer and flat. The eye ridges run across the axial furrow into the anterior of the glabella, and laterally connect directly into the palpebral lobes that are arcuate, slightly depressed, separated by a distinct shallow palpebral lobe and are adjacent to the posterior two thirds of the glabella. The posteroirs of the palpebral lobes are just anterior to the posterior of the glabella. The anterior course of the facial suture is slightly divergent from the anterior course of the eye ridges then curving diagonally across the border.

Thoracic segments have short articulating half rings, well impressed pleural furrows near the anterior of the segment and spinose pleural extremities that are progressively more posteriorly curved towards the posterior.

Pygidium is semicircular with slight excavation in posterior margin. Axis is relatively narrow, convex, of four well defined axial rings and a terminus that is very weakly divided laterally into another two or three rings and although finishing well inside the border furrow is connected to the margin by a low, very narrow ridge. Pleural and interpleural furrows are impressed with the latter usually more prominent laterally. The pleural furrows are transverse or just slightly behind transverse until they reach the border then they turn strongly posteriorly. The doublure is narrow and is widest laterally but tapers to nothing at the broad short articulating facet.

Formation and Locality: Bailiella-Lioparia Zone, Hsuchuanc Formation, a short distance north of Maotun, a small village in Fuchouwan, Liaoning.

Maotunia liaotungensis (Resser & Endo, 1937)

(Plate 84, figures 2—9)

1937 Mapania ? liaotungensis Resser & Endo, p. 252, pl. 34, figs 23, 24.
1965 Ptychoparia ? grabau; Chang in Lu et al., p. 124, pl. 20, figs 4—7.
1965 Manchuriella liaotungensis; Chang in Lu et al., p. 299, pl. 53, figs 15—17.
**Lectotype (designated herein):** USNM 86866a the cranidium figured by Resser & Endo (1937, pl. 34, fig. 24 centre).

**Description:** The cranidium is moderately convex in lateral profile but relatively flat in anterior profile. The glabella tapers gently forward to a broadly rounded anterior that may be straight across the axis. Four pairs of glabellar furrows are present with 1P well impressed and with a deeper part laterally representing a pit. Furrows 1P, 2P and 3P do not reach the axial furrow and are directed posteriorly towards the axis. Furrow 3P is very poorly impressed and often is not present or at least not visible. Furrow 4P is narrow, joins with the axial furrow and is directed forward axially. The preglabellar furrow has a pair of wide pits laterally. The occipital furrow is well impressed, curves slightly forward over the axis in some specimens, has a pair of wide deep pits laterally and shallows and lengthens over the axis. The occipital ring is long axially, tapers laterally, and has a prominent anterior median node. The brim bears a prominent caecal network and in some specimens (including the lectotype) a very low almost unnoticeable ridge anteromedially that possibly represents the beginning of a plectrum. The border furrow is shallow but distinct. The anterior border is of variable length, slightly upturned and flat to gently convex. The eye ridge is wide having a slightly greater width than the palpebral lobe, has a medial ridge running along it, and is continuous directly into the palpebral lobe with which it forms a semicircular arc. The anterior parts of the facial suture diverge slightly forward from the eye and curve adaxially near the axial furrow to cut the border diagonally. The posterior cephalic border becomes longer laterally as does the posterior border furrow.

The pygidium is semicircular with a transverse to slightly indented section posteromedially. The axis is narrow and convex, standing entirely above the pleural areas. It consists of 3 well defined rings and a long terminus that is weakly segmented laterally. The axis reaches very close to the margin posteriorly where the doublure is very short. The two anterior rings are posteriorly excavated by interpleural ridges. On the pleural areas pleural furrows are well impressed to the inner edge of the doublure, then they shallow and swing posteriorly finishing a very short distance abaxially. Weakly impressed interpleural furrows to the inner edge of the doublure. Interpleural ridges are present on the anterior two segments running diagonally across the rib from its posterior at the axial furrow to its anterior at the inner edge of the doublure. Articulating facets are short, wide and not distinct. The border is flat and narrow, tapers posteriorly and is horizontal.

**Discussion:** The material preserved in shale, named *Mapania? liaotungensis* by Resser & Endo (1937) appears a little different from that in limestone called *Psychoparia grabaui* by Resser & Endo (1937) in degrees of shape of some features but in the major features of the exoskeleton the two are identical. After the effects of slaty cleavage and vertical compression are eliminated we consider these to be conspecific. The pygidia look most dissimilar but the shale specimen has been crushed in the axis so that the axial furrow region has spread apart giving the appearance of a wider axis. The slaty cleavage has shortened the specimen relative to its width also. In the posterior part of the axis and pleural areas the structure is completely obliterated.

This species differs from *M. semiplectra* in the longer brim.

**Formation and Locality:** Changhia Formation at Jinjiachengzi near Fuchouwan and at Xipianling, a small village southwest of Qiaotou, Taizihe district, Liaoning.

**Maotunia distincta** (Resser & Endo, 1937)

(Plate 82, figures 5—14; plate 83, figures 2—12)

1913 *Anomocarella chinensis* Walcott, p. 200, pl. 20, fig. 4. (not figs 3, 3a-d or 4a)

1937 *Anomocarella distincta* Resser & Endo, p. 168, pl. 34, figs 7, 9. (cranidium only)(not pl. 32, fig. 21)

1937 *Anomocarella wallicottii* Resser & Endo, p. 168, pl. 34, fig. 8. (cranidium only)

1937 *Manchuriella iutai* Resser & Endo, p. 247, pl. 36, fig. 5.

1965 *Anomocarella distincta*; Chang in Lu et al., p. 319, pl. 58, fig. 24. (not fig. 25)
1965 Anomocarella walcotti; Chang in Lu et al., p. 325, pl. 60, fig. 9. (not fig. 10)
1965 Manchuriella hatai; Chang in Lu et al., p. 299, pl. 54, fig. 14.

**Holotype** (by original designation): USNM 58209 the cranidium figured by Resser & Endo (1937, pl. 34, fig. 7).

**Material:** A large collection of some 50 cranidia and pygidia is available in the Smithsonian collection.

**Diagnosis:** A *Maotunia* of moderate convexity, with the length of cranidium and width across palpebral lobes approximately equal. Glabella long, occupying 0.8 of cephalic length, with round to semitruncated anterior, very weak glabellar furrows in large specimens only and low convexity in both major directions. Preglabellar field very short to absent. Anterior border flat, and upturned, with a plectrum. Palpebral lobes long, gently arcuate. Posterior cephalic limb short and wide.

**Description:** Cranidium of moderate size with moderately steep slope to anterior in anterior part of glabella in lateral profile and down posterior cephalic limb in anterior profile, and with smooth surface. Glabella occupying large part of cranidial surface, approximately 0.8 of cranidial length, with straight slightly forward tapering sides, a rounded to subtruncated anterior, and 4 pairs of very indistinct lateral glabellar furrows visible only on larger specimens and then best exhibited on exfoliated cranidia. Furrow 1P forked adaxially and with furrow 2P running slightly posterior of transverse from the axial furrow. Furrow 3P transverse and narrower still with furrow 4P the narrowest of all; with both these anterior furrows running forward out of the axial furrow, 4P being immediately behind the eye ridge. Axial furrow weakly impressed with slightly deeper parts at abaxial end of furrow 1P and at anterolateral corners and distinct shallowing over the sagittal line anteriorly. Occipital furrow moderately impressed, with apodemes (pits) laterally separated from the axial furrow by the very shallow parts. Occipital ring elongate in central portion, flat in sagittal section and bearing a small prominent median node just in front of its midlength. Preglabellar field downsloping and short, either as long as or shorter than border. Anterior border furrow not impressed, defined only as a change in slope and interrupted by the plectrum. Anterior border flat, upturned, gently arched in anterior profile and with plectrum that tapers posteriorly then expands again laterally close to the glabellar anterior. Eye ridge low, narrow, crossing axial furrow into anterolateral corners of glabella in most specimens. Palpebral lobes gently arcuate, 0.4 to 0.45 of glabellar length, flat, often with slightly laterally sloping mid section, narrow but wider than eye ridge, defined by well impressed palpebral furrow that is continuous behind the eye ridge into the axial furrow and that shallows very markedly near the midlength of the palpebral lobe. Fixed cheek (including palpebral lobe) of variable width from 0.45 to 0.52 of basal glabellar width, with narrow fixed cheek often being compensated by wide palpebral lobes (pl. 8, fig. 1). Posterior cephalic limb wide, short, tapering strongly laterally with posterior part of facial suture crossing border furrow at a low angle. Posterior border furrow reaching axial furrow just in front of posterior margin and at posterior of occipital ring. Anterior part of facial suture diverging slightly forward and straight or convex out.

Pygidium semicircular, of low convexity; axis narrow, tapering, convex, of 6 rings and a small lunate terminus; postaxial ridge low, reaching margin; pleural and interpleural furrows present, only very faint across border; border narrow, of uniform width, divided from pleural areas only by a change of slope, with small median excavation in posterior.

**Discussion:** This species exhibits considerable variation in development of the plectrum, convexity of the fixed cheek, anterior glabellar shape, fixed cheek width, preglabellar field length and in the anterior part of the facial suture. Much of this variation is more apparent than real as several of the characters vary with size of the cranidium and also depend on whether or not the specimen is exfoliated. Damage to a specimen may also give the impression of variation, especially quantitative, that is not borne out by measurement. However, there is a deal of intraspecific variation that caused Resser & Endo (1937) to erect at
least two other synonymous species. When the whole population is looked at and the single locality is considered these must be included in one species as here indicated. Some of the variation may be due to sexual dimorphism but without correctly assigned pygidia it would be premature to make any such suggestion. Distinction of this from other species of the genus is relatively clear and needs no comment at this stage.

**Formation and Locality:** Crepicephaling Zone, Changhia Formation, (35n) northeast coastal region of Changxingdao Island, Liaoning.

**Maotunia blackwelderi (Resser & Endo, 1937)**

(Plate 76, figures 8—13; plate 77, figure 2)

1913 *Anomocarella chinensis*; Walcott, p. 200, pl. 20, fig. 4a (not pl. 20, figs 3a-d, 4)

1937 *Anomocarella blackwelderi* Resser & Endo, p. 170, pl. 33, fig. 10; pl. 34, figs 10—19.

1965 *Anomocarella (?) blackwelderi*; Chang in Lu et al., p. 326, pl. 60, figs 15—19.

**Holotype** (designated herein): USNM 58210 the complete dorsal shield figured by Walcott (1913, pl. 20, fig. 4a).

**Description:** Dorsal shield elliptical, cephalon semicircular flattened anteriorly; sagittal length of cephalon, thorax and pygidium in ratio of 3:3.5:1; axial furrow well impressed; glabella convex, truncatoconical, glabellar furrows faint; fixed cheek narrow about as wide as 0.25 of the basal glabellar width; eye ridge narrow, palpebral lobe large sickle-shaped, high and prominent; palpebral furrow well—impressed; posterior cephalic limb very wide and short; posterior border furrow long and shallow, posterior border short and convex; anterior border furrow short and deep; anterior border convex, short, with a prominent beginning of a plectrum posteromedially; anterior sections of facial suture slightly divergent from the palpebral lobes. Free cheek with broad genal regions and well defined lateral border; genial spine short; rostral plate narrow, V-shaped in lateral profile, with middle of posterior margin curving backward. Thorax of ten segments, pleural furrows long, well impressed, pleural spines short, curved posteriorly and broadly triangular.

Pygidium small, transverse; axis tapering backward, with three axial rings and a terminus, pleural regions with two pairs of broad pleural furrows and two pairs of narrow interpleural furrows, border very short sagittally, broader laterally.

**Discussion:** This species differs from *Anomocarella* in glabellar shape and in the relative size of the pygidium apart from other more detailed features. It is assigned to *Maotunia* on the basis of its anterior border, glabella, thoracic pleural and pygidial pleural structures. Although the pygidium is much smaller than in *M. semiplectra* it does have the pleural and interpleural furrows and narrow doublure of that species. It is not unlike *Anomocarella bella* in some respects and may be considered a descendant of and closely related to the species through which *Anomocarella* evolved. Whereas *Anomocarella* evolved towards a longer cranium and large pygidium this parallel lineage evolved a squat cephalon and small pygidium.

**Formation and Locality:** Amphoton Zone, Changhia Formation, (36g) Changxingdao Island, Liaoning.