

论寒武纪三叶虫 *Prodamesella* 属^{*}

袁金良

(中国科学院南京地质古生物研究所 南京 210008)

尹恭正

(贵州省地质矿产局区调院 贵阳 550005)

提要 根据贵州东部万山镇之南羊尾舟至寄马冲剖面中晚寒武世花桥组和车夫组所产丰富的新材料, 将 *Prodamesella* 分成 3 个亚属: *Prodamesella* (*Prodamesella*) Chang 1957, *Prodamesella* (*Metaprodamesella*) subgen. nov., *Prodamesella* (*Neoprodamesella*) subgen. nov.; 鉴于头盖和尾部的特征, 将 *Prodamesella* 从 Damesellidae 科移至 Missisiquoiidae 科, 并扼要地讨论该科内属的系统演化关系。此外, 记述 5 新种(新亚种): *Prodamesella* (*Prodamesella*) *lata* sp. nov., *Prodamesella* (*Prodamesella*) *cylindrica* sp. nov., *Prodamesella* (*Metaprodamesella*) *triangulata prisca* subgen. et subsp. nov., *Prodamesella* (*Metaprodamesella*) *granulosa* subgen. et sp. nov., *Prodamesella* (*Neoprodamesella*) *spinosa* subgen. et sp. nov.。

关键词 *Prodamesella*, 分类位置, 系统演化

贵州东部万山镇之南羊尾舟至寄马冲剖面的生物地层、三叶虫动物群曾有过系统的研究(杨家骝, 1978; 尹恭正, 1978; 袁金良、尹恭正, 1998)。笔者在研究此剖面上多节类三叶虫的过程中, 发现一些三叶虫属的分类位置、系统演化关系很值得深入研究和探讨, 如 *Prodamesella* Chang 1957, *Protaitzeoia* Yang 1978, *Aplotaspis* Henderson 1976, *Fenghuangella* Yang 1978, *Tangshihlingia* Chu

1959 等。本文就 *Prodamesella* 属作深入的研究, 其余各属将陆续发表。文中所用野外采集号 WY11F-WY12F 代表中寒武统花桥组顶部; WY14F-WY20F6 代表上寒武统车夫组的 *Formosagnostus formosus*-*Blackwelderia* 带; WY21F-WY23F 代表车夫组的 *Glyptagnostus stolidotus* 带。其剖面位置参见袁金良、尹恭正(1998)资料。本文图版照片由胡尚卿摄制, 笔者深致谢意。

ON THE GENUS *PRODAMESELLA* CHANG 1957 (CAMBRIAN TRILOBITA)

YUAN Jin-Liang

(Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008)

YIN Gong-Zheng

(Geological Survey, Guizhou Bureau of Geology and Mineral Exploration and Development, Guiyang 550005)

Key words *Prodamesella* (Trilobita), systematic position, phylogeny

Based on new material from the Middle and Upper Cambrian (Huaqiao Formation and Chifu Forma-

tion) of eastern Guizhou, South China, the genus *Prodamesella* is here revised and subdivided into

收稿日期: 1997-12-15

*国家自然科学基金项目(49262011)成果

three subgenera: *Prodamesella* (*Prodamesella*) Chang 1957, *Prodamesella* (*Metaprodamesella*) subgen. nov., *Prodamesella* (*Neoprodamesella*) subgen. nov. According to cranial and pygidial features, *Prodamesella* is here transferred from Damesellidae to Missisiquoiidae; tentative phylogeny of Missisiquoiidae is briefly discussed.

1 INTRODUCTION

The genus *Prodamesella* Chang 1957, one of the very interesting genera of late Middle Cambrian to Late Cambrian, is widely distributed in North and South China, Australia and Kazakhstan. Since its establishment as one of the genera under Damesellidae Kobayashi 1935, its pygidium has never been found (Chang, 1957, 1959; Jell and Robison, 1978; Ergaliev, 1980; Peng, 1987; Zhang and Jell, 1987; Guo *et al.*, 1996). However, the pygidial structure is of very importance in the discrimination of different genera and their interrelationship at the level of family, because pygidial structure remains comparatively stable over a wide range of genera. In the present paper many well-preserved specimens, both cranidia and pygidia, from the late Middle Cambrian to early Late Cambrian Huaqiao Formation and Chefu Formation in Jimachong section, Wanshan District, eastern Guizhou, South China, provide significant data on their systematic position and phylogeny.

2 SYSTEMATIC POSITION OF *PRODAMESELLA*

Lu *et al.* (1963) and subsequent authors (Lu *et al.*, 1965; Jell and Robison 1978; Ergaliev, 1980; Peng, 1987; Zhang and Jell, 1987; Guo *et al.*, 1996) assigned *Prodamesella* to the family Damesellidae Kobayashi 1935 based on the general configuration of cranium. The Damesellidae with type genus *Damesella* Walcott 1905 is characterized mainly by its tapering glabella with 2–3 pairs of oblique lateral furrows, relatively longer palpebral lobes, relatively deeper anterior border furrow, narrower posterolateral limbs (exsag.), subisopygous pygidium with less segmented axis, obsolete interpleural furrows on pleural area and well developed marginal spines. In

general configuration of cranium, especially the general outline of cranium and glabella, the absence of preglabellar field, *Prodamesella* is quite similar to *Damesella*, but that it differs from the latter in having rather small exoskeleton, subcylindrical to cylindrical glabella with more or less developed median notch and with 3 or 4 pairs of short, deep lateral furrows at sides, wider fixed cheeks, rather short and more advanced palpebral lobes and subtriangular pygidium with or without ill-defined marginal spines. These features coincide with those of *Parakoldinoidia* Endo 1937, *Missisiquoia* Shaw 1951 and *Tangshanaspis* Zhou et Zhang 1978, which are grouped within the family Missisiquoiidae Hupé 1955. In this case *Prodamesella* should be transferred from Damesellidae to Missisiquoiidae.

4 PHYLOGENY OF THE FAMILY MISSISQUOIIDAE HUPÉ 1955

Because some morphological features, such as the longer and less tapered glabella with short deeply incised lateral furrows at sides and with more or less developed median notch, the absence of preglabellar field, the wider fixed cheeks, rather short palpebral lobes and wider longer posterolateral limbs (tr. and exsag.), are considered as synapomorphy of Missisiquoiidae, the following genera or subgenera are here grouped within the family Missisiquoiidae: *Prodamesella* (*Prodamesella*) Chang 1957, *Prodamesella* (*Metaprodamesella*) subgen. nov., *Prodamesella* (*Neoprodamesella*) subgen. nov., *Parakoldinoidia* Endo in Resser and Endo 1937, *Pseudokoldinoidia* Endo 1944, *Tangshanaspis* Zhou and Zhang 1978, *Missisiquoia* Shaw 1951, *Lunacrania* Kobayashi 1955 and *Hardyia* Walcott 1924. *Prodamesella* (*Prodamesella*) is here considered to be its main root-stock. The earliest known species, *Prodamesella convexa* Chang 1957, occurs in the middle part of upper Middle Cambrian (*Amphoton* Zone) of North China. It appears to have flourished in the transitional region (western Hunan and eastern Guizhou) during the latest Middle Cambrian time. *Prodamesella* (*Prodamesella*) *lata* sp. nov. and *Prodamesella* (*Prodamesella*) *cylindrica* sp. nov. are representatives.

al., 1996, p. 122.

Type species *Prodamesella convexa* Chang, 1957.

Assigned subgenera *Prodamesella* (*Prodamesella*) Chang 1957, *Prodamesella* (*Metaprodamesella*) subgen. nov., *Prodamesella* (*Neoprodamesella*) subgen. nov.

Occurrence Late Middle Cambrian to early Late Cambrian; China, Kazakhstan and Australia.

Revised diagnosis Glabella tapering, parallel sided to slightly expanded forward, broadly rounded anteriorly, with or without median notch and with 3 or 4 pairs of short deep lateral furrows at sides; preglabellar field absent; anterior border furrow distinct, meeting axial furrow in front of glabella; anterior border convex, slightly upturned or slightly padded, broadening medially, narrowing laterally; fixed cheeks very broad; eye ridges low, transverse or slightly slanting backward or forward; palpebral lobes short, remote from glabella, located anteriorly; anterior branches of facial sutures short, convergent forward from palpebral lobes; posterior branches very long, slanting backward; pygidium semielliptical to subtriangular; axis long, with 7–9 axial rings; pleural area with 3–5 pairs of pleural ribs; pleural furrows distinct, interpleural furrows very shallow; pygidial border absent; pygidium with or without poorly developed marginal spines; sculpture on the surface of cranidium and pygidium consists of small pits or fine closely spaced granules.

Discussion Jell in Jell and Robison (1978, p. 17) correctly considered that *Damesella quadrata* Resser and Endo 1937 and *Olenoides manchuriensis* Endo 1944, which were tentatively referred to *Prodamesella* by Chang (1959, p. 219), should be excluded from that genus. Later Zhang and Jell (1987, p. 212) insisted that *Prodamesella* is the correct placement for *Damesella quadrata* with the untouched photograph available and after examination of the type specimen (Zhang and Jell, 1987, pl. 100, figs. 5, 6). However, *Damesella quadrata* has much larger quadrate cranidium, much deeper axial furrow anteriorly, narrower strongly upsloping fixed cheeks, much longer palpebral lobes and much narrower posterolateral limbs (exsag.). These features differ considerably from all known representatives of *Prodamesella*.

sella. Therefore we prefer to list *Damesella quadrata* under *Protaitzehoia* Yang 1978 rather than under *Prodamesella* Chang 1957.

Subgenus *Prodamesella* (*Prodamesella*) Chang, 1957

Type species *Prodamesella convexa* Chang, 1957.

Assigned species *Prodamesella* (*Prodamesella*) *convexa* Chang 1957, *Prodamesella* (*Prodamesella*) *biserrata* Jell 1978, *Prodamesella* (*Prodamesella*) *lata* sp. nov., *Prodamesella* (*Prodamesella*) *cylindrica* sp. nov.

Diagnosis Cranidium moderately vaulted, trapezoidal in outline; glabella tapering or parallel sided, with or without median notch, with 3 to 4 pairs of short deeply incised lateral furrows; anterior border furrow distinct, meeting with axial furrow medially; anterior border convex or slightly upturned; axial furrow deep, shallowing anteriorly; occipital ring prominent, narrowing laterally; fixed cheeks broad; eye ridges transverse or slightly slanting backward; palpebral lobes short, distant from glabella, located in front of glabellar mid-length; posterolateral limbs wide and long; pygidium semielliptical, with relatively short and narrow axis and wider pleural area; sculpture on the surface of cranidium and pygidium consisting of small pits, dense puncta or smooth.

Prodamesella (*Prodamesella*) *convexa* Chang, 1957 (Pl. I, fig. 1)

1957 *Prodamesella convexa* Chang, p. 20, pl. 1, fig. 5.

1959 *Prodamesella convexa*, Chang, p. 196–197, 218, pl. 1, fig. 13; text-figs. 3, 4.

1960 *Prodamesella convexa*, Kobayashi, p. 352, text-figs. 2a, b.

1965 *Prodamesella convexa*, Lu et al., p. 397, pl. 74, fig. 13.

non 1980 *Prodamesella convexa*, Ergaliev, p. 151–152, pl. 2, fig. 10.

1983 *Prodamesella convexa*, Qiu et al., p. 178, pl. 58, fig. 2.

Holotype Cranidium (pl. I, fig. 1); 9296.

Type locality Poshan, Shantung, North China.

Occurrence Changhia Formation (*Amphoton* zone); North China.

Prodamesella (*Prodamesella*) *lata* sp. nov. (Pl. I, figs. 2, 3)

Holotype Cranidium (pl. I, fig. 2); NIGP

128789.

Type locality Jimachong, Wanshan District, eastern Guizhou, South China.

Type stratum uppermost part of Huaqiao Formation (uppermost Middle Cambrian).

Diagnosis Cranidium moderately vaulted, semicircular in outline; glabella long and slender, cylindrical in outline, with ill-defined median notch; anterior border narrow and short (tr.); fixed cheeks very broad; eye ridges low, slightly slanting backward or transverse; palpebral lobes narrow and short, located opposite to in front of mid-length of glabella; pygidium semielliptical; axis with 5–6 rings; pleural area broader than axis, with 4 pairs of pleural ribs; pygidial border and border furrow absent.

Description Cranidium of very small size (maximum length 1.2 mm), moderately vaulted, length to breadth ratio about 6:11, semicircular in outline; axial furrow deeply incised laterally, shallowing anteriorly; glabella long and slender, cylindrical in outline, with ill-defined median notch, reaching anterior border furrow anteriorly, occupying about $\frac{5}{7}$ total cranial length, with 3 pairs of short lateral furrows, of which the S₁ and S₂ are oblique; the S₃ is transverse; occipital furrow distinct, slightly bending backward; occipital ring short (sag.) and convex, narrowing laterally, with a small occipital node; anterior border furrow shallow, slightly bending backward medially; anterior border narrow and short (tr.), slightly upturned; fixed cheeks very broad, about 1.4 times as wide as glabella between palpebral lobes, and more than 2 times as wide as glabella posteriorly; eye ridges low and faint, almost transverse or slightly slanting backward; palpebral lobes short and narrow, remote from glabella, about $\frac{1}{3}$ of glabellar length, located opposite to in front of mid-length of glabella; postero-lateral limbs very broad (exsag.) and long (tr.); posterior border furrow deep and broad; posterior border narrow, gently convex; anterior branches of facial sutures strongly convergent from palpebral lobes, posterior branches slanting backward. Pygidium tentatively assigned to new species with short and wide, semielliptical outline; axis tapering backward, with 5–6 axial rings; pleural area broad, moderately vaulted, with 4 pairs of pleural ribs; pleural furrows deep and broad, inter-

pleural furrows narrow and shallow; pygidial border and border furrow absent; a few small puncta on the surface of cheek area.

Comparison The new species differs from *Prodamesella* (*Prodamesella*) *convexa* Chang, mainly in having narrower and slender cylindrical glabella with shorter lateral furrows, narrower and shorter anterior border, much wider fixed cheek and wider (tr.) postero-lateral limbs and posterior border.

***Prodamesella* (*Prodamesella*) *cylindrica* sp. nov.**

(Pl. I, figs. 4–9, 13)

Holotype Cranidium (pl. I, fig. 6); NIGP 128793.

Type locality Jimachong, Wanshan District, eastern Guizhou, South China.

Type stratum From uppermost Huaqiao Formation (latest Middle Cambrian) to lowest Chefu Formation (earliest Late Cambrian) (WY 11F1, 12F1, 14F2).

Diagnosis Cranidium moderately vaulted, trapezoidal in outline; glabella robust, cylindrical in outline, gently expanded anteriorly, with distinct median notch and 3 pairs of short deeply incised lateral furrows; occipital ring prominent, with 2–3 indistinct posteromedial pits; anterior border furrow deep, broadening medially; anterior border narrow, gently convex; eye ridges transverse or slightly bending forward from anterior glabellar corners; palpebral lobes very short, distant from glabella, placed opposite to anterior glabellar lobe; pygidium semicircular in outline; axis short, with 5–6 axial rings; pleural area broad, with 4 pairs of pleural ribs; pygidial border and border furrow absent; surface of cranidium and pygidium rather smooth.

Description Cranidium moderately vaulted, trapezoidal in outline, gently arched anteriorly, length to width ratio about 4:7; axial furrow deep and broad medially and posteriorly, narrow and shallow anteriorly; glabella robust, cylindrical in outline, slightly expanded anteriorly, with a distinct median notch and 3 pairs of deep, short suboval lateral furrows, of which the S₃ is isolating from axial furrows; occipital furrow distinct; occipital ring prominent, slightly narrowing laterally, with 2–3 indistinct posteromedial pits; anterior border furrow deep, broad-

ening medially; anterior border lower than glabella, narrow and gently convex; fixed cheeks broad, gently upsloping from axial furrows, then strongly downsloping outward and backward, about 0.6–0.7 times as wide as glabella between palpebral lobes, 1.4 times as wide as glabella posteriorly; eye ridges transverse or slightly bending forward from anterior glabellar corners; palpebral lobes very short, distant from glabella, placed opposite anterior glabellar lobe, occupying about 1/4 to 1/3 of glabellar length; posterolateral limbs very broad (exsag.) and long (tr.); anterior branches of facial sutures short, convergent from palpebral lobes, posterior branches long, slanting backward; posterior border furrow deep; posterior border narrow, gently convex; pygidium tentatively assigned to this species semicircular in outline, length to width ratio about 1:2; axis short, with 5–6 axial rings; pleural area broad, with 4 pairs of pleural ribs; pleural furrows deep, interpleural furrows shallow; pygidial border and border furrow absent; surface of cranidium and pygidium rather smooth.

Comparison In general outline of cranidium the new species bears the closest resemblance to *Prodamesella* (*Prodamesella*) *biserrata* Jell from the late Middle Cambrian (*Peronopsis opimus* zone) of northwestern Queensland, Australia (Jell in Jell and Robison, 1978, p. 17, pl. 1, fig. 9; pl. 2, figs. 1–6), however, it can be discriminated from the latter mainly by its cylindrical glabella with shorter lateral furrows, its more advanced eye ridges and palpebral lobes, its wider fixed cheek, and less narrowing laterally occipital ring with only 2–3 indistinct postero-medial pits. In general configuration of cranidium, especially glabella, *Prodamesella* (*Prodamesella*) *cylindrica* sp. nov. is quite similar to *Prodamesella* (*Prodamesella*) *lata* sp. nov., but the latter has rather slender glabella with ill-defined median notch, narrower (sag.) occipital ring with a small node and much broader fixed cheeks and shorter pygidium.

***Prodamesella* (Metaprodamesella) subgen. nov.**

Type species *Prodamesella subtriangulata* Peng, 1987.

Etymology Met, meta(Gr.) = occurring later, in succession to, after, referring to the new subgenus occurring later than the nominate subgenus *Prodame-*

sella (*Prodamesella*) stratigraphically.

Assigned species and subspecies *Prodamesella* (*Metaprodamesella*) *punctata* Ergaliev 1980, *Prodamesella* (*M.*) *subtriangulata* Peng 1987, *Prodamesella* (*M.*) *subtriangulata prisca* subgen. et subsp. nov., *Prodamesella* (*M.*) *granulosa* subgen. et sp. nov.

Diagnosis Glabella with hexagonal anterior lobe and distinct median notch; 3 to 4 pairs of lateral glabellar furrows short and shallow; anterior border furrow narrow and distinct, curving backward medially; anterior border low, pickaxe-shaped, gently convex; eye ridges transverse or slightly bending forward; palpebral lobes very short, located opposite to anterior glabellar lobe; pygidium long, subtriangular in outline, with suppressed relief posteriorly; axis long and broad, slowly tapering backward, with 6–7 axial rings; pleural area with 4–5 pairs of pleural ribs, of which anterior bands are broader than posterior bands (exsag.); pygidial border and border furrow absent; sculpture on the surface of cranidium and pygidium consists of closely spaced fine granules and sporadically larger granules.

Discussion *Prodamesella* (*Metaprodamesella*) subgen. nov. differs from *Prodamesella* (*Prodamesella*) chiefly in having subtriangular or semielliptical cranidium, longer subcylindrical glabella with hexagonal frontal lobe and 4 pairs of shorter, shallower glabellar furrows, lower gently convex pickaxe-shaped anterior border, bending medially and shallowing anterior border furrow, more advanced eye ridges and palpebral lobes, longer subtriangular pygidium with longer broader axis and finer as well as coarser granules on the surface of cranidium and pygidium.

Age and distribution Early Late Cambrian; South China and Kazakhstan.

***Prodamesella* (Metaprodamesella) subtriangulata Peng, 1987**

(Pl. I, figs. 21, 22; Pl. II, figs. 1–16)

1987 *Prodamesella subtriangulata* Peng, p. 105, pl. 8, fig. 3.

Holotype Cranidium (pl. II, fig. 16); NIGP 74559.

Type locality Waergang, Taoyuan county, Hunan, South China.

Type stratum Chefu Formation (*Liostracina*-*Ammagnostus sinensis* Zone, WT10).

Occurrence Chefu Formation (from *Formosagnostus formosus*-*Blackwelderia* Zone to *Glyptagnostus stolidotus* Zone); Waergang, Taoyuan, western Hunan and Jimachong, Wanshan District, eastern Guizhou, South China (WY20F3, 20F4, 20F5, 21F2).

Description Cranidium moderately to strongly vaulted, subtriangular in outline, moderately to strongly arched anteriorly, length to breadth ratio about 1:1.5; glabella very slowly tapering forward posteriorly and medially, then gently expanded for a very short distance, very weakly narrowing anteriorly, forming hexagonal frontal lobe, with distinct median notch and with $3-4$ pairs of lateral furrows; the S_1-S_3 are slanting backward and the S_4 is slanting forward; occipital ring prominent, wider than glabella at the base, gently narrowing laterally; anterior border low and gently convex, pickaxe-shaped; anterior border furrow narrow and distinct laterally, shallowing and curving backward medially, meeting axial furrow at median notch; fixed cheeks moderately convex, narrower than glabella between palpebral lobes, as wide as occipital ring posteriorly; eye ridges transverse or slightly bending forward from middle part of frontal glabellar lobe; palpebral lobes very short, located opposite to frontal glabellar lobe, occupying about $1/5$ of glabellar length; posterolateral limbs broad (exsag.); anterior branches of facial sutures very short, strongly convergent from palpebral lobes, posterior branches very long, slanting backward with a gentle arc; posterior border narrow, gently convex; posterior border furrow deep; pygidium moderately vaulted, subtriangular in outline; axis long, slowly tapering backward, with $6-7$ axial rings; axial ring furrows distinct anteriorly, very shallow posteriorly; pleural area with $4-5$ pairs of pleural ribs, of which anterior bands are broader than posterior bands (exsag.), suppressed relief posteriorly; pygidial border and border furrow absent; sculpture on the surface of cranidium and pygidium consists of closely spaced very fine granules and sporadically a few larger granules.

Prodamesella (*Metaprodamesella*) *subtriangulata*

prisca **subgen. et subsp. nov.**

(Pl. I, figs. 10-12)

Holotype Cranidium (pl. I, fig. 11); NIGP 128798.

Type locality Jimachong, Wanshan District, eastern Guizhou, South China.

Type stratum The base of Chefu Formation (lower part of *Formosagnostus formosus*-*Blackwelderia* Zone).

Occurrence At the type locality and type stratum (WY 14F2)

Description Cranidium moderately vaulted, subtrapezoidal in outline, very weakly arched forward, length to breadth ratio about 1:1.6-1.7; glabella subcylindrical in outline, very slowly tapering, hardly expanded anteriorly, with weakly developed median notch and with $3-4$ pairs of short shallow glabellar furrows; occipital furrow shallow; occipital ring prominent, with a small median node; anterior border furrow shallow; anterior border low, pickaxe-shaped, slightly upturned, with a transverse ridge on its outer margin; fixed cheeks moderately vaulted, narrower than glabella between palpebral lobes, nearly as wide as glabella posteriorly; eye ridges very low, slightly curving forward from anterior or glabellar corners; palpebral lobes very short, located more advanced; posterolateral limbs very broad (exsag.); anterior branches of facial sutures very short, convergent from palpebral lobes, posterior branches slanting backward with a gentle arc; sculpture on the surface of anterior border consisting of fine granules; on the other parts of cranidium rather smooth.

Comparison The new subspecies is different from *Prodamesella* (*Metaprodamesella*) *subtriangulata subtriangulata* Peng mainly in the subtrapezoidal cranidium with broader and very weakly arched anterior margin, less expanded frontal glabellar lobe, and wider anterior border with a transverse ridge on its outer margin.

Prodamesella (*Metaprodamesella*) *granulosa*
subgen. et sp. nov.

(Pl. I, figs. 14-19)

Holotype Cranidium (pl. I, fig. 15); NIGP 128802.

Type locality Jimachong, Wanshan District, eastern Guizhou, South China.

Type stratum Lower part of Chefu Formation (lower part of *Formosagnostus formosus-Blackwelderia* Zone).

Occurrence at type locality and type stratum (WY 18F1).

Diagnosis Cranidium trapezoidal in outline, very gently arched forward; glabella slowly tapering medially and posteriorly, gently expanded anteriorly, with distinct median notch and with 4 pairs of deeper lateral furrows; occipital ring prominent, with a small occipital node; anterior border furrow narrow and distinct, gently bending forward laterally, strongly bending backward medially; anterior border low, pickaxe-shaped; eye ridges slightly bending forward; pygidium upsidedown trapezoidal in outline; axis with 5–6 axial rings; pleural area with 2–3 pairs of pleural ribs; sculpture on the surface of cranidium and pygidium consists of closely spaced fine granules and sporadic larger granules.

Description Cranidium moderately vaulted, very gently arched anteriorly, trapezoidal in outline, length to width ratio about 1:1.6; glabella slowly tapering posteriorly and medially, gently expanded anteriorly, with a distinct median notch and with 4 pairs of deeply incised short lateral furrows; the S_1 is deepest and oblique; the S_2 is very gently slanting, located at the mid-line of glabella; the S_3 is represented by small pits and the S_4 is shallow and long, slightly slanting forward; occipital furrow deep; occipital ring prominent and highly elevated, wider than glabella at the base, with a occipital node; axial furrow deep, shallowing around frontal glabellar lobe; anterior border furrow narrow and distinct, gently bending forward laterally, strongly bending backward and meeting axial furrow medially; anterior border low, very gently convex, pickaxe-shaped, with a transverse ridge on its outer margin; fixed cheeks moderately vaulted, as wide as glabella between palpebral lobes, about 1.3 times as wide as glabella at the base posteriorly; eye ridges distinct, very gently bending forward from median portion of frontal glabellar lobe; palpebral lobes very short, about $1/6-1/5$ of total glabellar length, placed more advanced; posterolateral limbs very broad (exsag.)

and long (tr.); posterior border furrow deep; posterior border narrow, gently convex; anterior branches of facial sutures short, convergent forward, posterior branches long, slanting backward; pygidium moderately vaulted, upsidedown trapezoidal in outline, with rather straight posterior margin; axis long, with 5–6 axial rings; pleural area with 2–3 pairs of pleural ribs and suppressed relief posteriorly; pygidial border and border furrow absent; sculpture on the surface of cranidium and pygidium consists of closely spaced granules and sporadic larger granules.

Comparison In general configuration of cranidium the new species bears the closest resemblance to *Prodamesella* (*Metaprodamesella*) *subtriangulata prisca* subsp. nov., but it has rather deeper axial furrows, occipital furrow, glabellar furrows, anterior and posterior border furrows, wider (tr.) fixed cheeks and closely spaced granules and sporadic larger granules on the surface of cranidium. In general configuration of cranidium the new species is also quite similar to *Prodamesella* (*Metaprodamesella*) *punctata* (Ergaliev, 1980, p.152, pl.6, fig.8), but the latter has shorter truncated conical glabella without distinct median notch, transverse eye ridges and punctulate surface of cranidium.

Prodamesella (*Neoprodamesella*) subgen. nov.

Type species *Prodamesella* (*Neoprodamesella*) *spinosa* subgen. et sp. nov.

Etymology Ne-, neo(Gr.)=new, fresh, young and combined with genus *Prodamesella* Chang, 1957.

Diagnosis Cranidium gently to moderately vaulted, subtrapezoidal in outline, nearly straight anteriorly; glabella slowly tapering forward, parallelsides anteriorly, with a median notch and with 4 pairs of short deeply incised lateral furrows, of which the S_3 is represented by small oval pits, isolated from axial furrow; anterior border furrow shallow, almost straight or slightly bending backward medially; anterior border low and flat; occipital ring prominent, broader than glabella at the base; fixed cheeks very broad; eye ridges transverse or slightly bending forward; palpebral lobes very short, remote from glabella, located opposite to frontal glabellar lobe; pygidium moderately vaulted, semielliptical in outline; axis

long, tapering backward, with 8–9 axial rings; pleural area wider than axis, with 5–6 pairs of pleural ribs, suppressed relief posteriorly; pygidium with 9 pairs of ill-defined marginal spines, of which the fifth pair is the longest; sculpture on the surface of cranidium and pygidium consists of closely spaced fine granules and sporadic larger granules.

Discussion In general outline of cranidium and glabella, the new subgenus closely resembles *Prodamesella* (*Prodamesella*) Chang 1957, it is, however, readily discriminated from the latter mainly in having slender less vaulted glabella with 4 pairs of lateral furrows of which the S₃ being isolated from axial furrows), broader fixed cheeks (tr.), shorter more advanced palpebral lobes, longer pygidium with 9 pairs of marginal spines and longer narrower axis bearing 9 axial rings. In general outline of cranidium and pygidium *Prodamesella* (*Neoprodamesella*) is also quite similar to *Prodamesella* (*Metaprodamesella*) subgen. nov., but the latter has expanded hexagonal frontal glabellar lobe, pickaxe-shaped anterior border, subtriangular to semielliptical cranidium, relatively narrower fixed cheeks and no pygidial marginal spine. In general configuration of cranidium and pygidium, especially the presence of pygidial marginal spines, the new subgenus is closely related to *Tangshanaspis* Zhou and Zhang, with *T. zhaogezhuangensis* Zhou and Zhang 1978 as the type species, from the uppermost part of Fengshan Formation of Zhaogezhuang, Tangshan, Hebei, North China (Zhou and Zhang, 1978, p. 15–16, pl. 1, figs. 22, 23; Zhou and Zhang, 1984, p. 97–98, pl. 3, fig. 5; pl. 20, figs. 12–14; pl. 22, fig. 21; pl. 24, fig. 15; pl. 27, fig. 3), however, it can be distinguished from the latter chiefly by its narrower truncated conical glabella, broader fixed cheeks between palpebral lobes, more advanced shorter palpebral lobes, shallower pleural and interpleural furrows and less developed marginal spines on pygidium.

Age and distribution Early Late Cambrian; South China.

***Prodamesella* (*Neoprodamesella*) *spinosa* subgen. et sp. nov.**

(Pl. II, figs. 17–24)

Holotype Cranidium, (pl. II, fig. 19); NIGP

128827.

Type locality Jimachong, Wanshan District, eastern Guizhou, South China.

Type stratum Upper part of Chefu Formation (*Glyptagnostus stolidotus* Zone, WY 23F1).

Occurrence At the type locality and type stratum.

Diagnosis The same as the generic diagnosis.

Description Cranidium gently to moderately vaulted, subtrapezoidal in outline, nearly straight anteriorly, length to width ratio about 1:2; axial furrow deeply incised medially and posteriorly, shallow anteriorly; glabella moderately vaulted, slowly tapering, nearly parallel-sides anteriorly, occupying about 2/3 of total cranial length, a little longer than wide, with a median notch and with 4 pairs of short deeply incised lateral furrows, of which the S₁ and S₂ are short and slightly oblique; the S₃ is represented by small oval pits and isolated from axial furrows; the S₄ is shallow, slightly slanting forward; occipital furrow deep laterally, very shallow medially; occipital ring prominent, broader than glabella at the base, gently narrowing laterally, with a small median node; anterior border furrow shallow, almost straight or slightly bending backward medially; anterior border low and flat, slightly narrowing laterally; fixed cheeks very broad, nearly as wide as glabella between palpebral lobes, about 1.2 times as wide as glabella at the base posteriorly; eye ridges transverse or slightly bending forward from anterior glabellar corners; palpebral lobes very short, remote from glabella, located opposite to anterior glabellar lobe; posterolateral limbs broad (exsag.) and long (tr.); posterior border furrow deep and broad, shallowing abaxially; posterior border very gently convex; anterior branches of facial sutures short, distinctly convergent from palpebral lobes, posterior branches long, slanting backward; pygidium moderately vaulted, semielliptical in outline, length to width ratio about 2:3; axis long, tapering backward, with 8–9 axial rings; axial ring furrows distinct anteriorly, obscure posteriorly; pleural area wider than axis (tr.), suppressed relief posteriorly, with 5–6 pairs of pleural ribs; pleural furrows distinct, interpleural furrows very shallow; pleural ribs extending posterolaterally, and forming 9 pairs of marginal spines, of which the fifth pair is the

longest; sculpture on the surface of cranidium and pygidium consists of closely spaced fine granules plus scattered larger granules.

REFERENCES

- Chang W T, 1957. Preliminary note on the Lower and Middle Cambrian stratigraphy of Poshan, central Shantung. *Acta Palaeont. Sinica*, 5(1):13—31 (in Chinese with English summary)
- Chang W T, 1959. New trilobites from the Middle Cambrian of North China. *Acta Palaeont. Sinica*, 7(3):193—236 (in Chinese with English summary)
- Dean W T, 1977. The Early Ordovician trilobite genus *Missisiquoia* Shaw, 1951 in the southern Canadian Rocky Mountains of Alberta and British Columbia. *Pap. Can. Geol. Surv.*, 76(33):1—6
- Duan J Y, An S L, Zhao D, 1986. Cambrian-Ordovician boundary and its interval biotas, southern Jilin, Northeast China. *Journal of Changchun College of Geology. Speci. Issue of stratigraphy and Palaeontology*, 1—124
- Endo R, 1944. Restudies on the Cambrian formations and fossils in southern Manchoukuo. *Cent. nat. Mus. Manchoukuo Bull.*, 7:1—100
- Ergaliev G K H, 1980. Middle and Upper Cambrian trilobites of the Malyi Karatau Range. *Acad. Sci. Kazakh. SSR. K. I. Satpaev. Inst. geol. sci. "Nauka" Publ. House, Alma-Ata*, 1—221 (in Russian)
- Guo H J, Zan Sh Q, Luo K L, 1996. Cambrian stratigraphy and trilobites of eastern Liaoning. *Changchun: Jilin University Press*. 184pp. (in Chinese with English summary)
- Jell P A, Robison R A, 1978. Revision of a late Middle Cambrian trilobite faunule from northwestern Queensland. *Univ. Kansa Paleont. Contrib. Pap.*, 90:1—24
- Kobayashi T, 1955. The Ordovician fossils of the McKay Group in British Columbia, western Canada, with a note on the Early Ordovician palaeogeography. *J. Fac. Sci. Imp. Univ. Tokyo Ser.*, 2(9):355—493
- Kobayashi T, 1960. The Cambro-Ordovician formations and faunas of South Korea, part 7, *Palaeontology* 6. *J. Fac. Sci. Univ. Tokyo sect.*, 2(12):329—420
- Lu Y H, Chu C L, Chien Y Y, 1963. Trilobites. *Beijing: Science Press*. 186pp. (in Chinese)
- Lu Y H, Chang W T, Chu C L, Chien Y Y, Hsiang L W, 1965. Chinese fossils of all groups. *Chinese trilobita*, 2 vols. 766pp. *Beijing: Science Press*. (in Chinese)
- Ludvigsen R, Westrop S R, 1983. Franconian trilobites of New York state. *New York State Museum and Science Service Memoir*, 23: 1—83
- Peng Sh Ch, 1987. Early Late Cambrian stratigraphy and trilobite fauna of Taoyuan and Cili, Hunan. In: *Nanjing Institute of Geology and Palaeontology, Academia Sinica collection of postgraduate theses*. Nanjing: Jiangsu Science and Technology Publishing House. 53—134 (in Chinese with English summary)
- Qiu H A *et al.*, 1983. Trilobita. In: *Palaeontological Atlas of East China*, vol. 1. Beijing: Geological Publishing House. 28—254. (in Chinese)
- Resser C E, Endo R, 1937. Description of the fossils. In: Endo and Resser "The Sinian and Cambrian formations and fossils of southern Manchoukuo". part II. *Manch. Sci. Mus. Bull.*, 1:103—301, 370—434
- Shaw A B, 1951. The paleontology of northwestern Vermont I. New Late Cambrian trilobites. *J. Paleont.*, 25(1):97—114
- Shergold J H, 1980. Late Cambrian trilobites from the Chatsworth Limestone, western Queensland. *Bull. Miner. Resour. Geol. Geophys Aust.*, 186:1—111
- Walcott C D, 1924. Cambrian geology and paleontology 5. no. 2 Cambrian and Lower Ozarkian trilobites. *Smith. Misc. Coll.*, 75: 53—60
- Westrop S R, 1986. Trilobites of the Upper Cambrian Sunwaptan stage, southern Canadian Rocky Mountains. *Alb. Palaeontog. Canad.*, 3:1—179
- Winston D, Nicholls H, 1967. Late Cambrian and Early Ordovician faunas from the Wilberns Formation of central Texas. *J. Paleont.*, 41(1):66—96
- Yang J L, 1978. Middle and Upper Cambrian trilobites of western Hunan and eastern Guizhou. *Prof. Pap. of Stratigraphy and Palaeontology, Chinese Academy of Geological Sciences*, no. 4:1—82. Beijing: Geological Publishing House (in Chinese with English abstract)
- Yin G Z, Li S J, 1978. Trilobita. In: *Palaeontological atlas of southwestern China, Guizhou Province*, part 1, 385—594, 798—829. Beijing: Geological Publishing House (in Chinese)
- Zhang W T, Jell P A, 1987. Cambrian trilobites of North China. *Chinese Cambrian trilobites housed in the Smithsonian Institution*. Beijing: Science Press. 1—459pp
- Zhou Z Y, Zhang J L, 1978. Cambrian-Ordovician boundary of the Tangshan area with the descriptions of the related trilobite fauna. *Acta Palaeont. Sinica*, 17(1):1—26 (in Chinese with English summary)
- Zhou Z Y, Zhang J L, 1984. Uppermost Cambrian and Lowest Ordovician trilobites of North and Northeast China. *Stratigraphy and palaeontology of systematic boundaries in China, Cambrian-Ordovician boundary (2)*. Hefei: Anhui Science and Technology Publishing House. 63—163

Explanation of Plates

The specimens described here were collected from Huaqiao Formation (WY 11F1—WY 12F1; latest Middle Cambrian) and Chefu Formation (WY 14F1—23F2; early Late Cambrian) of Yangweizhou—Jimachong section, Wanshan District, eastern Guizhou, South China and deposited in Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences.

Plate I

1. *Prodamesella* (*Prodamesella*) *cornwexa* Chang, 1957
Cranidium (holotype), $\times 10$, field no. C17, Cat. no. 9296, Changhia Formation (*Amphoton* Zone); Poshan, Shantung, North China.
- 2, 3. *Prodamesella* (*Prodamesella*) *lata* sp. nov.

2. Cranidium (holotype), $\times 24$, field no. WY 11F1, cat. no. NIGP 128789.

3. Pygidium, $\times 24$, field no. WY 11F1, cat. no. NIGP 128790.

Uppermost part of Huaqiao Formation; Jimachong, Wanshan District, eastern Guizhou, South China.

4—9, 13. *Prodamesella (Prodamesella) cylindrica* sp. nov.

4. Cranidium, $\times 18$, field no. WY 11F1, cat. no. NIGP 128791. 5. Juvenile cranidium, $\times 18$, field no. WY 12F1, cat. no. NIGP 128792.

6. Cranidium (holotype), $\times 18$, field no. WY 12F1, cat. no. NIGP 128793. 7. Exfoliated cranidium, $\times 24$, field no. WY 12F1, cat. no. NIGP 128794.

8. External imprint of pygidium, $\times 24$, field no. WY 12F1, cat. no. NIGP 128795. 9. Juvenile cranidium, $\times 18$, field no. WY 12F1, cat. no. NIGP 128796.

Uppermost part of Huaqiao Formation; Jimachong, Wanshan District, eastern Guizhou, South China.

13. Cranidium, $\times 20$, field no. WY 14F2, cat. no. NIGP 128800.

Lowest part of Chefu Formation (*Formosagnostus formosus-Blackwelderia* Zone); Jimachong, Wanshan District, eastern Guizhou, South China.

10—12. *Prodamesella (Metaprodamesella) subtriangulata prisca* subgen. et subsp. nov.

10. Cranidium, $\times 24$, field no. WY 14F2, cat. no. NIGP 128797. 11. Cranidium (holotype), $\times 24$, field no. WY 14F2, cat. no. NIGP 128798. 12. Juvenile cranidium, $\times 24$, field no. WY 14F2, cat. no. NIGP 128799.

Lowest part of Chefu Formation (*Formosagnostus formosus-Blackwelderia* Zone); Jimachong, Wanshan District, eastern Guizhou, South China.

14—19. *Prodamesella (Metaprodamesella) granulosa* subgen. et sp. nov.

14. Cranidium, $\times 18$, field no. WY 18F1, cat. no. NIGP 128801. 15. Cranidium (holotype), $\times 18$, field no. WY 18F1, cat. no. NIGP 128802.

16. Juvenile cranidium, $\times 24$, field no. WY 18F1, cat. no. NIGP 128803. 17. Cranidium, $\times 24$, field no. WY 18F1, cat. no. NIGP 128804.

18. Cranidium, $\times 18$, field no. WY 18F1, cat. no. NIGP 128805. 19. Pygidium, $\times 24$, field no. WY 18F1, cat. no. NIGP 128806.

Lower part of Chefu Formation (*Formosagnostus formosus-Blackwelderia* Zone); Jimachong, Wanshan District, eastern Guizhou, South China.

20. *Prodamesella (Metaprodamesella)* sp.

Cranidium, $\times 18$, field no. WY 23F2, cat. no. NIGP 128807. Uppermost part of Chefu Formation (upper part of *Glyptagnostus stolidotus* Zone); Jimachong, Wanshan District, eastern Guizhou, South China.

21, 22. *Prodamesella (Metaprodamesella) subtriangulata* Peng, 1987

21. Cranidium, $\times 24$, field no. WY 20F3, cat. no. NIGP 128808.

22. Cranidium, $\times 24$, field no. WY 20F3, cat. no. NIGP 128809.

Middle part of Chefu Formation (upper part of *Formosagnostus formosus-Blackwelderia* Zone); Jimachong, Wanshan District, eastern Guizhou, South China.

Plate II

1—16. *Prodamesella (Metaprodamesella) subtriangulata* Peng, 1987

1. Cranidium, $\times 24$, field no. WY 20F3, cat. no. NIGP 128810. 2. Cranidium, $\times 24$, field no. WY 20F3, cat. no. NIGP 128811.

3. Cranidium, $\times 24$, field no. WY 20F4, cat. no. NIGP 128812. 4. Pygidium, $\times 24$, field no. WY 20F4, cat. no. NIGP 128813.

5. Juvenile cranidium, $\times 18$, field no. WY 20F4, cat. no. NIGP 128814. 6. Pygidium, $\times 24$, field no. WY 20F4, cat. no. NIGP 128815.

7. Juvenile cranidium, $\times 18$, field no. WY 20F5, cat. no. NIGP 128816. 8. Cranidium, $\times 18$, field no. WY 20F5, cat. no. NIGP 128817.

9. Cranidium, $\times 18$, field no. WY 20F5, cat. no. NIGP 128818. 10. Pygidium, $\times 24$, field no. WY 20F5, cat. no. NIGP 128819.

11. Cranidium, $\times 24$, field no. WY 20F5, cat. no. NIGP 128820. 12. Cranidium, $\times 24$, field no. WY 20F5, cat. no. NIGP 128821.

13. Cranidium, $\times 24$, field no. WY 20F5, cat. no. NIGP 128822. 14. Pygidium, $\times 24$, field no. WY 20F5, cat. no. NIGP 128823.

15. Cranidium, $\times 24$, field no. WY 21F2, cat. no. NIGP 128824.

Chefu Formation (from *Formosagnostus formosus-Blackwelderia* Zone to *Glyptagnostus stolidotus* Zone); Jimachong, Wanshan District, eastern Guizhou, South China.

16. Cranidium (holotype), $\times 24$, field no. WT10, cat. no. 74559.

Chefu Formation (*Liostracina-Ammagnostus sinensis* Zone); Taoyuan, western Hunan, South China.

17—24. *Prodamesella (Neoprodamesella) spinosa* subgen. et sp. nov.

17. Pygidium, $\times 24$, field no. WY 23F1, cat. no. NIGP 128825. 18. Pygidium, $\times 18$, field no. WY 23F1, cat. no. NIGP 128826.

19. Cranidium (holotype), $\times 18$, field no. WY 23F1, cat. no. NIGP 128827. 20. Pygidium, $\times 18$, field no. WY 23F1, cat. no. NIGP 128828.

21. Cranidium, $\times 15$, field no. WY 23F1, cat. no. NIGP 128829. 22. Pygidium, $\times 24$, field no. WY 23F1, cat. no. NIGP 128830.

23. Cranidium, $\times 18$, field no. WY 23F1, cat. no. NIGP 128831. 24. Cranidium, $\times 20$, field no. WY 23F1, cat. no. NIGP 128832.

Chefu Formation (*Glyptagnostus stolidotus* Zone); Jimachong, Wanshan District, eastern Guizhou, South China.



