

EARLY CAMBRIAN MALONG FAUNA AND GUANSHAN FAUNA
FROM EASTERN YUNNAN CHINA

云南东部 早寒武世马龙动物群 和关山动物群

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云南东部早寒武世 马龙动物群和关山动物群

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· 昆 明 ·

Early Cambrian Malong Fauna and Guanshan Fauna from Eastern Yunnan, China

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内 容 简 介

本书系统总结了云南东部早寒武世马龙动物群和关山动物群的综合研究成果, 简略讨论了后生动物的早期演化和震旦纪生物群的分布, 寒武纪生命大爆发和寒武纪早期生物演化的意义。进一步探讨了云南东部早寒武世岩石地层和年代地层的划分及化石分带。详细论述了下寒武统红井哨组和乌龙箐组的岩石沉积特征, 马龙动物群和关山动物群的研究概况、各类生物组合特征、地层、地理分布。分类描述了马龙动物群和关山动物群的古生物化石 15 个门类、50 属 75 种 (其中 10 个新属 22 个新种)。附有 40 幅精美的彩色化石图版。

该书选题新, 内容新, 并有不少新的古生物化石发现, 附有精美的彩色化石图版, 对于国内外相关专业的科研、教学单位有重要参考价值。对博物馆和图书馆有收藏价值, 对地质勘查人员也有参考作用。

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前 言

20 世纪 50 年代以来,在中国西南部的早、中寒武世地层中相继发现和报道了 5 个重要的后生动物化石群:梅树村动物群、澄江动物群、马龙动物群、关山动物群和凯里动物群。20 世纪 70~80 年代,围绕着中国震旦系—寒武系界线层型的研究,对梅树村动物群作了深入细致的研究工作,已取得国际先进水平的研究成果。20 世纪 80 年代以来的 20 多年间,澄江动物群和凯里动物群的研究也取得突破性的进展。但对早寒武世中期的马龙动物群和关山动物群的研究,一直停留在 20 世纪 80 年代的水平上。然而由距今 5.3 亿年早寒武世筇竹寺期的澄江动物群到距今 5.15 亿年的中寒武世凯里动物群之间,还有间隔 1500 万年的沧浪铺期和龙王庙期的沉积。在这段地层中发现和研究软躯体后生动物化石群,对进一步探讨澄江动物群的演化、寒武纪生命大爆发及寒武纪早期生物演化都具有重要的意义。沧浪铺期的马龙动物群和关山动物群的发现和研究正好填补了这一空白。

为此,自 2003 年 10 月以来,云南省地质科学研究所与深圳市仙湖植物园古生物博物馆合作,相继开展了“云南早寒武世关山动物群”(2003 年 10 月~2004 年 10 月,编号 YIGS-2003-01)和“云南东部早寒武世马龙动物群和关山动物群”(2006 年 1 月~2007 年 12 月,编号 YIGS-2006-01)的研究项目。该项目由云南省地质科学研究所罗惠麟教授级高工和深圳古生物博物馆傅晓平馆长共同负责完成项目的组织实施和研究工作。

2005 年,项目组还得到中国科学院南京地质古生物研究所杨群研究员和金玉环院士负责的国家科技部重大基础前期研究专项《天体生物学的古生物途径》(编号 2002CCA03300)的资助。在该项目之下设立了分项目“云南武定早寒武世关山动物群研究”(2004 年 12 月~2005 年 12 月)及云南省地质科学研究所立项:“昆明地区早寒武世关山动物群”(2006 年 1 月~12 月,编号 YIGS-2006-02)的资助。

本项目研究自 2003 年 10 月开始,到现在已有 4 年多的时间,其中野外工作达 4 个多月。共测量和观察地层剖面 7 条,采集各类古生物化石 3335 件(其中马龙动物群 764 件,关山动物群 2571 件)。经过室内详细的鉴定和系统研究,取得下列主要成果和认识:

1. 对后生动物的早期演化有了进一步的认识,简略讨论了震旦纪(伊迪卡拉纪)早期的翁安生物群、庙河生物群和晚期的西陵峡生物群、高家山生物群及江川生物群的组合特征和时代分布,并与澳大利亚的伊迪卡拉动物群和俄罗斯的白海生物群作了比较。

2. 根据云南东部早寒武世马龙动物群和关山动物群的研究结果,认为寒武纪生命大爆发由寒武纪早期的梅树村动物群开始,筇竹寺期的澄江动物群只是寒武纪生命大爆发的高峰期,而不是结束。它一直延续到早寒武世中期(沧浪铺期)的马龙动物群和关山

动物群,最后到中寒武世的凯里动物群和伯吉斯页岩动物群才算结束。

3. 进一步探讨了云南东部早寒武世的岩石地层和年代地层单位的划分和化石分带。认为渔户村组中谊村段与白岩哨段之间的小歪头山段与雨碌段(“待补段”)为相变关系,主要代表一级碳酸盐台上的二级台地和台凹地区不同相环境的沉积。晋宁梅树村剖面中谊村段与小歪头山段之间为整合过渡关系,局部地段为水下冲刷接触。

4. 根据云南东部下寒武统沧浪铺阶红井哨组和乌龙箐组地层剖面的详细研究和对比,认为小江古断裂是控制沧浪铺期沉积环境和生态环境的主要因素,从而将滇东地区分为昆明—武定区和马龙—宜良区两个生物地理区,详细讨论了两区的沉积特征和生物群分布规律。

5. 根据马龙动物群和关山动物群中三叶虫化石的地层分布,进一步探讨了云南东部下寒武统沧浪铺阶的 *Yiliangella* 带、*Drepanuroides* 带、*Palaeolenus* 带和 *Megapalaeolenus* 带 4 个化石带划分的可靠性,并详细讨论了 *Drepanuroides* 带生物化石的分布规律。

6. 简略记述了马龙动物群和关山动物群的地理分布。马龙动物群除滇东外,在滇东南、滇东北、黔北、川西、川北及陕南等地区均有发现,其产出层位基本上都属沧浪铺早期的地层。关山动物群在黔北、黔东及峡东地区相当于沧浪铺晚期的地层中已有发现。特别是黔东凯里地区的杷榔动物群和三峡地区石碑组的软躯体后生动物化石群,其时代与关山动物群基本相当。

7. 详细讨论了马龙动物群和关山动物群的生物组合特征。马龙动物群主要由三叶虫和腕足类组成,伴生有少量鳃虾和软舌螺的介壳化石及保存软躯体的奇虾和古虫动物。关山动物群的组成则类型多样,几乎澄江动物群的大部分门类在关山动物群中都已找到。如节肢动物门的三叶虫、三叶形虫、吐卓虫、等刺虫、鳃虾、金臂虫,并伴随着奇虾类、古虫动物、腕足动物、软舌螺、海绵动物、开腔骨类、鳃曳动物、腔肠动物、触手动物、棘皮动物和遗迹化石。

8. 在寻甸道院村剖面下寒武统红井哨组中部首次发现 *Malungia* 与 *Yiliangella* 共生。马龙红军哨砍斧箐剖面发现较少的鳃虾及个别的古虫动物。在马龙大箐红井哨组顶部采到保存较好的奇虾前附肢的化石标本。

9. 在昆明岗头村下寒武统乌龙箐组下部发现大量保存较好的古虫动物化石及三叶形虫新属种。昆明高楼房剖面乌龙箐组下部首次发现三叶形虫 *Leancoilia* 和保存完美的广卫虾(*Guangweicaris*)及奇虾的前附肢。乌龙箐组上部发现保存完美的 *Redlichia mai* Lu 及蠕形动物、海绵动物化石。武定石将军剖面乌龙箐组下部首次发现 *Redlichia yunnanensis* Resser et Endo (= *Redlichia major* Lu) 的完整个体及蠕形动物和始海百合类的棘皮动物化石。

10. 在昆明高楼房剖面乌龙箐组的三叶虫 *Redlichia mansuyi* Resser et Endo, *R. mai* Lu, *Palaeolenus lantenoisi* Mansuy 和广卫虾 *Guangweicaris spinatus* Luo, Fu at Hu 中首次发现保存软躯体的触角和附肢及蠕形动物 *Guanduscolex minor* Hu, Luo et Fu。

本书描述了云南东部早寒武世马龙动物群和关山动物群的生物化石共计 15 个门类,50 属 75 种(其中 10 个新属 22 个新种)。在本项目研究过程中已发表论文 8 篇,有 5 个新属 9 个新种已经发表。这些生物化石的详细研究,不仅增加了马龙动物群和关山动物

群的内容，而且对探讨寒武纪生命大爆发和寒武纪早期生物演化都有着重大的科学意义和实用价值。

本项目研究主要由深圳市仙湖植物园提供研究经费，由云南省地质科学研究所和深圳古生物博物馆负责组织实施。云南省地质调查院和深圳市仙湖植物园的领导对这项研究工作非常重视，并多方面给予指导和支持。在研究过程中，还得到科技部重大基础前期研究专项（2002CCA03300）、国家自然科学基金项目（40672004，40772020）及国家重点基础研究发展规划项目（2006CB806401）的支持。中国科学院南京地质古生物研究所金玉环院士、杨群研究员提供研究经费，张文堂、朱兆玲、钱逸、章森桂、朱茂炎、李国祥研究员，中国地质科学院项礼文研究员，西北大学舒德干、张兴亮教授、张志飞博士，贵州大学赵元龙、彭进教授提供有关资料，深圳古生物博物馆尤霆、段宗梁，中国科学院南京地质古生物研究所赵方臣博士参加部分野外工作，杨志参加采集化石标本，笔者在此深表谢意。由于时间紧迫，文中不当之处和错误的地方，敬请读者批评指正。

著 者

2008年3月3日

Summary

Since the 1950s, five important metazoan faunas have been discovered and reported from southwestern part of China, including the Meishucun fauna, the Chengjiang fauna, the Malong fauna, the Guanshan fauna, and the Kaili fauna. Among them, the Meishucun fauna and the Chengjiang fauna of Yunnan Province and the Kaili fauna of Guizhou Province have been studied extensively in recent years, and the work on Malong fauna and Guanshan fauna of Yunnan Province are still in preliminary research stage, which is the main focus of this project. The Malong fauna and Guanshan fauna occur stratigraphically in the Canglangpuan Stage, filling the time gap (15 Ma) between the older Chengjiang fauna (Cambrian Series 2) and the younger Kaili fauna (Cambrian Series 3) .

During October of 2003 to December of 2007, team members of the joint project collaborated between the Yunnan Institute of Geological Sciences, Kunming and the Shenzhen Palaeontological Museum, Shenzhen have carried out extensive fieldwork and made significant discoveries. Major achievements of studying the Malong fauna and the Guanshan fauna are listed below:

1. In eastern Yunnan, the “Cambrian explosion” has initiated from the Meishucun fauna (Meishucunian Stage), reached its diversity peak in the Chengjiang fauna (Qiongzhusian Stage), and persisted into the Malong fauna and the Guanshan fauna (Canglangpuan Stage) during the Cambrian Series 2.

2. The sedimentary environments and biographical distribution in eastern Yunnan during early Cambrian time was mainly controlled by the Xiaojiang Fault. The eastern Yunnan can be divided into two biogeographical areas: The Kunming—Wuding area and the Malong—Yiliang area. Sedimentary features and faunal distribution of each area are discussed herein in detail.

3. Based on the trilobite assemblages, four fossil zones of the Canglangpuan Stage, including the *Yiliangella* Zone, the *Drepanuroides* Zone, the *Palaeolenus* Zone, and the *Megapalaeolenus* Zone, that are named in previous studies are reexamined. In particular, the geostratigraphic distribution of *Drepanuroides* Zone is discussed in detail.

4. The Early Cambrian Malong fauna and its equivalent faunas are widespread in the Yangtze Platform, including some parts of Yunnan, Guizhou, Sichuan, and Shanxi Provinces. The Guanshan fauna mainly occurs in eastern Yunnan. However, its equivalent faunas have been reported elsewhere (i. e. , Balang fauna near the Kaili City, Guizhou and the soft-bodied fauna from the Shipai Formation, Three Gorges area) .

5. The Malong fauna is characterized by trilobites and brachiopods and associated with

shelly hyolithes and *Branchiopods*. A few taxa of anomalocaridids and vetulicoliids with soft – bodies are present. On the other hand, the faunal diversity of the overlying Guanshan fauna is relatively higher. Nearly all animal groups occurred in the Chengjiang fauna are also present in the Guanshan fauna. Arthropoda is the most diverse group, including trilobites, non – trilobite arthropods, bradoriids, *Tuzoia*, and *Isoxys*, in the Guanshan fauna. Other associated animal groups include vetulicoliids, priapulids, brachiopods, eocrinoid echinoderms, anomalocaridids, cancelloriids, sponges, hyolithids, algae, and trace fossils.

6. The co – occurrence of *Malungia* and *Yiliangella* has been reported for the first time from the middle part of the Early Cambrian Hongjingshao Formation in the Daoyuancun Villiage, Xundian County. *Branchiocaris* and *Vetulicola* are discovered from the Kanfuqing Section, Hongjunshao Villiage, Malong County. Well – preserved great appendages of *Anomalocaris* have been recovered from the top part of the Hongjingshao Formation, Daqing Village, Malong County.

7. Abundant well – preserved vetulicoliids and several nonbiomineralizing arthropods are discovered from the lower part of the Wulongqing Formation, Gangtoucun Section, Kunming. Specimens of *Anomalocaris*, priapulids, sponges, *Leancholia*, *Guangweicaris* with preserved soft – parts are collected from the Gaoloufang Section, Kunming. Priapulids and eocrinoid echinoderms are found at the Shijiangjun Section, Wuding.

8. Several trilobites, including *Redlichia mansuyi* Resser et Endo, *R. mai* Lu, *Palaeolenus lantenoisi* Mansuy, a non – trilobite arthropod *Guangweicaris spinatus* Luo, Fu et Hu, and a priapulid *Guanduscolex minor* Hu, Luo et Fu with preserved soft – parts are discovered from the Wulongqing Formation, Gaoloufang Section, Kunming.

Totally 50 genera and 75 species, including 10 new genera and 22 new species, belonging to 15 fossil groups of the Malong fauna and Guanshan fauna are described herein. Five new genera and nine new species, including *Yiliangocaris ellipticus* Luo et Hu, 1999, *Gangtoucunia aspera* Luo et Hu, 1999, *Vetulicola gangtoucunensis* Luo, Fu et Hu, 2005, *Panlongia tetranodusa* Liu et Luo, 2006, *P. spinosa* Liu et Luo, 2006, *Tuzoia tylodesa* Luo et Hu, 2006, *Isoxys wudingensis* Luo et Hu, 2006, *Guangweicaris spinatus* Luo, Fu et Hu, 2007, *Guanduscolex minor* Hu, Luo et Fu, 2008, have been published elsewhere since the completion of this work. New genus and species described in this book include: *Neomalungia magna* Luo et Hu (gen. et sp. nov.), *Yiliangella xundianensis* Luo et Hu (sp. nov.), *Kanfuqingia malongensis* Luo et Hu (gen. et sp. nov.), *Longquania bispinosa* Luo et Hu (gen. et sp. nov.), *Isoxys minor* Luo et Hu (sp. nov.), *Branchiocaris xundianensis* Luo et Hu (sp. nov.), *B. malongensis* Luo et Hu (sp. nov.), *B. yiliangensis* Luo et Hu (sp. nov.), *Westonia gubaiensis* Luo et Hu (sp. nov.), *Shitangsporgia lata* Liu (gen. et sp. nov.), *Wudingeocrinus rarus* Hu et Luo (gen. et sp. nov.), *Cruziana ludianensis* Luo et Gao (ichnosp. nov.), *Stipsellus gaoloufangensis* Luo et Hu (ichnosp. nov.) .

Detailed descriptions of the new genera and species are provided in the following section.

1. Trilobita

Genus *Neomalungia* Luo et Hu (gen. nov.)

Diagnosis Body large, cranidium sub - trapeziform in outline; glabella wide and cone - shaped, with 3 pairs of shallow glabellar furrows; occipital furrows shallow and wide; neck ring shows uniform width. Dorsal furrows narrow and shallow. Eye ridges short and unclear; eye lobes relatively large and convex outward. Fixigena relatively narrow. Posterolateral limb wide and large; posterior border furrow shallow and wide. Anterior limb narrow; anterior border wide and convex slightly. Anterior branch of the facial suture extends outward; posterior branch of the facial suture relatively long, extending backward and outward. Thorax with at least 16 thoracic segments; axial lobe wide, columnar in outline, with a node on each ring. Pleurae relatively narrow; pleural spines become longer backward. Pygidium probably small.

Discussion The new genus is similar to *Malungia* Lu, 1961 in the shape of the cranidium and glabella, but the latter differs by bearing a relatively narrow and cone - shaped glabella, large eye lobes, narrow fixigena, short posterolateral limbs, the wide anterior limb, distinctly outward extended anterior branches of the facial suture, and a thoracic region with 14 segments. The new genus is also similar to *Paramalungia* Chang, 1966, but the glabellar furrows, occipital furrows, and border furrows of the latter are unclear. The latter also differs in having a short posterolateral limb, a thoracic region with 11 segments, and a large pygidium.

Type species *Neomalungia magna* Luo et Hu (gen. et sp. nov.)

Age and geographical distribution Early Cambrian Canglanpuan Age; eastern Yunnan, China.

Neomalungia magna Luo et Hu (gen. et sp. nov.)

(Pl. 8, fig. 1)

Holotype Mhk - 1 - 530, Pl. 8, fig. 1.

Description A robust body, with a maximum length of 210 mm and a maximum width of 120 mm, and the ratio of length/width is 1 : 0.57. Cranidium sub - trapeziform in outline; glabella wide and cone - shaped, convex slightly, with 3 pairs of glabellar furrows. Dorsal furrows narrow and shallow. Occipital furrows shallow and wide. Neck ring has a uniform width. Eye ridges short and indistinct. Eye lobes relatively large and convex outward. Fixigena relatively narrow. Posterolateral limb wide and long; posterior border furrow shallow and wide; posterior border convex. Anterior limb narrow and concaves slightly. Anterior border relatively wide and convex slightly. Anterior branch of the facial suture extends outward; posterior branch of the facial suture long, extending backward and outward.

Thorax consists of at least 16 thoracic segments. Axial lobe relatively wide, columnar in outline, slightly contracting backward, with a node on each ring. Pleurae relatively narrow than axial lobe; pleura furrows shallow and wide; pleural spines become longer backward. Pygidium is unknown.

Occurrence and Strata Kanfuqing, Hongjunshao Village, Malong County, *Drepanuroides* Zone, Hongjingshao Formation, Lower Cambrian.

Genus *Yiliangella* Chang, 1966

***Yiliangella xundianensis* Luo et Hu (sp. nov.)**

(Pl. 15, figs. 1 – 6)

Holotype Xd – 1 – 118, Pl. 15, fig. 3.

Description Body medium to large sized, with a maximum length of 70 mm and a maximum width of 40 mm. The ratio of length/width is 1 : 0.57. Dorsal shield elongate and ovate in outline. Cranidium sub – trapeziform in outline; glabella convex, wide and cone – shaped, with 3 pairs of shallow and wide glabellar furrows. Occipital furrows shallow and wide; neck ring convex gently. Fixigena relatively narrow. Posterolateral limb wide and long, sub – triangular in outline. Posterior border furrow shallow; posterior border narrow and convex. Eye ridge distinct; eye lobe small. Anterior limb narrow and concave; anterior border wide and convex slightly. Anterior branch of the facial suture short, extending outward slightly; posterior branch of the facial suture long, extending backward and outward. Librigena relatively wide; genal spines short. Thorax relatively long, with 14 thoracic segments. Axial lobe slightly wider than pleurae, with a node on each ring; pleural spines medium long. Pygidium small; axial lobe convex, cylindrical in outline, becoming sharp slightly backward; pleurae flat, with a pairs of pleural furrows. Pygidial border extends backward and forms a pairs of triangular pygidial spines. The front part of the pygidial margin concave slightly.

Discussion The new species closely resembles the type species *Yiliangella foficula* Chang in its cranidium, the shape of the glabella, the features of the thoracic region and the pygidium. The former differs by bearing a wide and cone – shaped glabella, narrow fixigena, a preglabellar field, 14 thoracic segments, relatively short pleural spines, one pair of pygidial spines, and a wide and concave pygidial margin.

Occurrence and Strata Daoyuancun Village, Xundian County, Hongjingshao Formation, Lower Cambrian, occurring in association with *Malungia laevigata* Lu.

Genus *Kanfuqingia* Luo et Hu (gen. nov.)

Diagnosis Dorsal shield wide and ovate in outline. Cranidium sub – trapeziform in outline; glabella wide and cone – shaped, with 3 pairs of shallow and wide glabellar furrows. Occipital furrow shallow; neck ring bears nuchal nodes. Eye ridge long; eye lobe relatively small. Fixigena relatively narrow. Posterolateral limb triangular, wide and large. Posterior border furrow shallow and wide. Anterior limb narrow and concave. Anterior border convex, with a flat and straight front part. Anterior branch of the facial suture extend parallel; posterior branch of the facial suture extend backward and outward. Librigena relatively narrow; genal spines relatively short. Thorax consists of 18 thoracic segments, with a node on each axial ring; axial lobe slightly wider

than pleurae. Pleural spines long. Pygidium is not well preserved.

Discussion The new genus is similar to *Yiliangella* in the shape of cranidium, but the latter differs in having relatively large eye lobe, wide fixigena, the missing of anterior limb, narrow and convex anterior border, wide librigena, long genal spines, a thorax with 16 segments, and the long pleural spines.

Type species *Kanfuqingia malongensis* Luo et Hu (gen. et sp. nov.)

Age and geographical distribution Early Cambrian Canglanpuan Age; eastern Yunnan, China.

***Kanfuqingia malongensis* Luo et Hu (gen. et sp. nov.)**

(Pl. 17, fig. 4)

Holotype Mhk - 4 - 17, Pl. 17, fig. 4.

Description Body robust (150 mm in length and 85 mm in width). The ratio of length/width is 1 : 0.56. Dorsal shield wide and ovate in outline. Cranidium trapeziform in outline; glabella large, wide and cone-shaped, with 3 pairs of shallow and wide glabellar furrows. Occipital furrow shallow; neck ring has a uniform width and a small nuchal node. Eye ridge long, extending outward; eye lobe relatively small. Fixigena is relatively narrow. Posterolateral limb triangular, wide and large. Posterior border furrow shallow and wide. Posterior border is narrow, becoming wide slightly outward. Anterior limb is relatively narrow, convex slightly. Anterior border is convex, with a flat and straight front part. Anterior branch of the facial suture parallel and extend forward; posterior branch of the facial suture extend backward and outward. Librigena relatively narrow, with a wide and convex margin; genal spines relatively short. Thorax bears 18 thoracic segments; axial lobe wide, columnar and cone-shaped, with a node on each axial ring; axial lobe slightly wider than that of the pleurae. Pleural furrows and interpleural furrows distinctive; pleural spines are long. Pygidium poorly preserved.

Occurrence and Strata Kanfuqing, Hongjunshao Village, Malong County, *Drepanuroides* Zone, Hongjingshao Formation, Lower Cambrian.

2. Trilobitoidea

Genus *Longquania* Luo et Hu (gen. nov.)

Diagnosis Dorsal shield elongate - ovate in outline. Cephalon semi-circular, convex slightly, extending backward and forming a short, triangular genal angle on each side. A row of small nodes present on the posterior margin of the cephalon. Thorax consists of 11 tergites. Pleural spines wide and short. Telson small, triangular in outline; axial lobe convex; a pair of tail spines extends from the posterior margin of the telson, with a series of small, serrated spines present on inner side.

Discussion: The new genus shows a close resemblance to *Aglaspis* (Hesselbo, 1992) based on the semi-circular cephalon and 11 throacic tergites. However, the latter evidently differs in

having a pairs of dorsal eyes on its carapace, and much longer tail spines.

Type species *Longquania bispinosa* Luo et Hu (gen. et sp. nov.)

Age and geographical distribution Early Cambrian Canglanpuan Age; eastern Yunnan, China.

***Longquania bispinosa* Luo et Hu (gen. et sp. nov.)**

(Pl. 22, figs. 7 – 9)

Holotype Kgx – 4 – 233, Pl. 22, fig. 8.

Description Dorsal shield elongate – ovate in outline. Cephalon semi – circular, convex slightly, extending backward and forming a short and triangular genal angle on each side. A row of small nodes present on the posterior margin of the cephalon. The posterior margin of the cephalon is flat and straight. Thorax consists of 11 tergites; no distinct furrows on the axial lobe; pleural spines wide and short; terminal pair of the pleural spines relatively long, surrounding most part of the telson. Telson small, triangular in outline, with a convex axial lobe lacking segmentation. A pair of scissors – like tail spines extends from the posterior margin. A series of small, serrated spines present on inner side of the tail spines.

Occurrence and Strata Xiaochong, Gangtoucun Village, Shitangshan, Gaoloufang Village, Kunming City, the *Palaeolenus* Zone, lower part of the Wulongqing Formation.

3. Isoxyida

Genus *Isoxys* Walcott, 1890

***Isoxys minor* Luo et Hu (sp. nov.)**

(Pl. 27, figs. 4 – 7; Pl. 28, figs. 1 – 8)

Holotype Kgs – 1 – 106, Pl. 28, fig. 5.

Description: Valves small, normally 15 mm in length and 10 mm in height; the ratio of length /height is 1 : 0.67. Each valve is hemi – elliptical in outline with a straight hinge – line. An anterior cardinal spine and a posterior cardinal spine respectively present at the anterior and posterior side of each valve; anterior cardinal spine relatively longer than the posterior one. Valve expands at the anteroventral part and tapers at the posteroventral part. Ventral margin absent. External surface of both valves smooth, lacking of ornamentations.

Discussion The new species shows some resemblance to *I. auritus* (Jiang, 1982) in the outline of the valves and the shape of two cardinal spines. The latter differs in having a larger size (the length of the valve is 30 – 50 mm), a nearly equal – size anterior and posterior cardinal spines, a broad, distinct ventral margin, and web – like ornament on carapace surface.

Occurrence and Strata Shitangshan, Gaoloufang Village, Xiaochong, Gangtoucun Village, Kunming City and Sapushan, Shijiangjun, Wuding County, the *Palaeolenus* Zone, lower part of the Wulongqing Formation.

4. Branchiocaridida

Genus *Branchiocaris* Briggs, 1976

Branchiocaris xundianensis Luo et Hu (sp. nov.)

(Pl. 29, fig. 1)

Holotype Xd - 1 - 141, Pl. 29, fig. 1.

Description Bivalved arthropod. Carapace large (75 mm in length and 55 mm in height), elongate - elliptical in lateral view; length/height ratio 1 : 0.6. Hinge - line straight, slightly arched at the middle part. The anteroventral part expands and the posteroventral part contracts. Valves smooth and lack ornamentations. Neither anterior cardinal spine nor posterior cardinal spine preserved.

Discussion The new species has larger carapaces as that of *B. ? yunnanensis* Hou, 1987, but the latter differs by bearing a relatively higher carapace, the web - like ornaments on the carapace, and a different length /height ratio (1 : 0.8) . The new species also shows resemblance with *Pectocaris spectiosa* Hou, 1999 in the outline and the relative large size of the carapace. The major difference between the two species is the length /height ratio, which is 1.4 : 1 in the new species and 2 : 1 in the latter.

Occurrence and Strata Daoyuancun Village, Xundian County, Hongjingshao Formation, Lower Cambrian, occurring in association with *Yiliangella*.

Branchiocaris malongensis Luo et Hu (sp. nov.)

(Pl. 29, fig. 2)

Holotype Mhk - 1 - 533, Pl. 29, fig. 2.

Description Bivalved arthropod. Carapace large; sub - ovate in outline, 90 mm in length and 60 mm in height; length /height ratio 1 : 0.7. Hinge - line straight and long. Anteroventral part slightly expands forward; posteroventral part slightly contracts. Anterior and posterior cardinal spines not preserved. Carapace consists of irregularly arranged small pits and processes.

Discussion The new species has similar carapace shape with *B. ? yunnanensis* Hou, 1987, but the latter differs in having a relatively higher length/height carapace ratio (1 : 0.8), distinct anterior and posterior cardinal spines, a backward projected posteroventral part, and web - like ornamentations on carapace.

Occurrence and Strata Kanfuqing, Hongjunshao Village, Malong County, *Drepanuroides* Zone, upper part of the Hongjingshao Formation, Lower Cambrian.

Branchiocaris yiliangensis Luo et Hu (sp. nov.)

(Pl. 29, figs. 3 - 6)

Holotype Yl - 3 - 5, Pl. 29, fig. 4.

Description Bivalved arthropod. Carapace thin and medium - sized, 25 - 35 mm in length and 15 - 20 mm in height; length/height ratio 1 : 0.6; hemi - elliptical in lateral view. Hinge

– line straight, slightly concaved at the middle part. Anterior and posterior cardinal spines small and triangular in outline. Anteroventral part expands forward and posteroventral part tapers gradually backward. Carapace lacks ornamentations; ventral margin absent.

Discussion The new species differs from the type species, *B. ? pretiosa* (Resser, 1929) (Briggs et al., 1994, p. 140, fig. 93) by bearing a shorter carapace, a different length/height carapace ratio (1 : 0.6), and a smooth carapace. The new species is similar to *B. ? yunnanensis* Hou, 1987, but the latter differs in having a larger carapace with maximum length of 50 mm and maximum height of 40 mm, larger anterior and posterior cardinal spines, and web – like carapace ornamentations.

Occurrence and Strata Lihuazhuan Village, Caodian, Yiliang County, *Palaeolenus* Zone, lower part of the Wulonging Formation, Lower Cambrian.

5. Brachiopoda

Genus *Westonia* Walcott, 1901

Westonia gubaiensis Luo et Hu (sp. nov.)

(Pl. 33, figs. 8 – 14)

Holotype Wsh – 4 – 22, Pl. 33, fig. 9.

Description Valves robust, nearly round in outline, 18 mm in length and 20 mm in width. Anterior margin round; posterior margin tapers and forms an obtuse angle. An inclined furrow presents on either side of the beak of the dorsal valve. Distinct concentric growth lines and radiated lines present on the surface of the shell, forming a web – like appearance. Radiated ribs run from the umbo to commissure. Pedicle opening locates at the posterior end of the ventral valve.

Discussion The new species is similar to *W. leei* Sun from the upper part of the Hongjingshao Formation, but the latter differs in having a smaller body, finer concentric growth lines and radiated lines.

Occurrence and Strata Shijiangjun, Gubai Village, Wuding County, *Palaeolenus* Zone, lower part of the Wulonging Formation, Lower Cambrian.

6. Spongia

Genus *Shitangsporgia* Liu (gen. nov.)

Diagnosis Large, thin – walled sponge, elliptical in outline, with a contracted base and a possible wide osculum at top. Spicules fine and small. Skeleton composes of packed or irregular monaxons.

Type species *Shitangsporgia lata* Liu (gen. et sp. nov.)

Age and geographical distribution Early Cambrian Canglanpuan Age; eastern Yunnan, China.

Shitangsporgia lata Liu (gen. et sp. nov.)

(Pl. 36, figs. 4 – 7)

Holotype Kgs - 6 - 182, Pl. 36, fig. 5.

Description Body large and elliptical in outline, 55 mm in height and 35 mm in width, with a thin body wall. Spicules fine and small. Skeleton composes of irregularly packed monaxons. A possible wide osculum present at top.

Occurrence and Strata Shitangshan, Gaoloufang Village, Kunming City, the *Megapalaeolenus* Zone, upper part of the Wulongqing Formation.

7. Echinodermata

Genus *Wudingeocrinus* Hu et Luo (gen. nov.)

Etymology The generic name is derived from the Wuding County.

Diagnosis Small gogiid. Brachioles long and spirally coiled. Number of brachioles varies from 3 or 4 in juveniles to 7 or 8 in larger specimens. Theca long and reversely conical in outline, covered by irregular plates; sutural pores and epispines absent. Theca/stalk boundary indistinctive. Stalk long, polyplated, tapering distally and gradually to a point, with small platelets.

Discussion: Comparing with most species of *Gogia*, *Wudingeocrinus* gen. nov. differs by lacking sutural pores and epispines and bearing small number of brachioles, and a theca/stalk length ratio. The new genus is similar to the coeval *Guizhoueocrinus* (Zhao et al., 2007) from the early Cambrian Balang fauna. *Wudingeocrinus* gen. nov. differs by bearing a extremely long stalk, indistinctive theca/stalk boundary, and lacking sutural pores and epispines. The new genus also differs to two eocrinoids, *Sinoeocrinus* and *Globoeocrinus* from the Middle Cambrian Kaili biota (Parsley & Zhao, 2007; Lin et al., 2008) in having a long stalk, simple and irregular thecal plates and lacking sutural pores and epispines.

Type species *Wudingeocrinus rarus* Hu et Luo (gen. et sp. nov.)

Age and geographical distribution Early Cambrian Canglanpuan Age; eastern Yunnan, China.

***Wudingeocrinus rarus* Hu et Luo (gen. et sp. nov.)**

(Pl. 38, figs. 1 - 6)

Holotype Wsh - 14 - 25, Pl. 38, fig. 1.

Etymology Specific name refers to the rarity of the specimens.

Materials At least 10 articulated individuals are studied, including juveniles.

Description Individuals small in size, ranging from 15 mm in body length (measured from the end of the stalk to the top of the theca) in juveniles up to 40 mm in larger specimens. Each individual consists of bronchioles, a theca, and a stalk. Brachioles long and spiral, covered by alternating series of brachiolar plates. Number of brachioles varies from 3 or 4 in juveniles to 7 or 8 in larger specimens. Theca long, and reversely conical in outline, tapering posteriorly toward the stalk; thecal plates irregular; neither sutural pores nor epispines have been observed. Stalk long, tapering posteriorly and gradually to an end point. Theca/stalk boundary indistinctive.