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论凯里组*

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提要　记述了黔东南凯里组三叶虫的地层分布,讨论了三叶虫的分带,根据三叶虫地层分布情况,将凯里组与国内外同期地层进行了对比,指出了凯里生物群与布吉斯页岩生物群,斯潘塞页岩生物群出现的顺序,对于深入研究凯里生物群与其它生物群的演化具有重要意义。

关键词　凯里组　分带与对比　黔东南

1　前言

黔东南的凯里组是凯里生物群的产出层位,但是它与国内外其它地区精确的地层对比还没有深入的研究。要弄清凯里生物群与北美著名的布尔吉斯页岩(Burgess Shale)生物群,斯潘塞页岩(Spence Shale)生物群的演化关系,必须首先弄清这几个动物群的地质时代。因而研究凯里组的时代及其对比对于深入研究凯里生物群与其它动物群的演化关系具有重要意义。

凯里组一名系卢衍豪(1963)所建,标准剖面在贵州省丹寨县南皋乡,为一套厚 260m 的灰绿、黄绿色含云母粉砂质粘土页岩、泥岩,其时代为早寒武世。1970 年笔者曾与张正华、周志毅等人实测了南皋剖面,逐层采集了大量的三叶虫化石,经研究将此剖面详细的生物地层资料于"西南地区的寒武系"一文内发表(张文堂等,1979),作者将原始的凯里组含义略有扩大,即在凯里组之上卢衍豪称之为高台组的 30 余米的灰色薄层灰岩、泥质灰岩亦划归凯里组,时代为中寒武世。随着生物地层资料的逐步积累和研究的不断深入,凯里组是一个跨早、中寒武世的地层单位才逐渐为世人所认识(赵元龙等,1993)。

2　凯里组三叶虫地层分布及分带(表Ⅰ)

凯里组三叶虫的研究始于 70 年代(卢衍豪,1974a,1974b),大量新属种的描述和分类见于 80 年代(张文堂等,1980;卢衍豪、钱义元,1983),进入 90 年代又陆续有所发现(赵元龙等,1990,1994;袁金良等,1994,1997;黄友庄等,1994;郭庆军等,1998)。到目前为止共描述

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了 40 余属 90 余种,但是一些种的归属及分类位置上仍然存在一些问题。经笔者研究,将这些种合并为 41 属(亚属)(见附录),它们在凯里组的分布情况见表Ⅰ。

表Ⅰ 凯里组三叶虫属(亚属)的地层分布

Stratigraphic distribution of trilobite genera (subgenera) from the Kaili Formation

	Kaili Formation	
	Lower Cambrian	Middle Cambrian
Balangcunaspis Yuan et Zhao, 1997		
Bathynotus Hall, 1860		
Burlingia Walcott, 1908		
Chengshanaspis Chang, 1963		
Chittidilla (*Diandongaspidella*) Yuan, 1997		
Danzhaiaspis Yuan et Zhou, 1980		
Danzhaina Yuan, 1980		
Eokaotaia Yuan et Zhao, 1994		
Jiumenia Yuan, 1980		
Kailiella Lu et Chien, 1974		
Kaotaia Lu, 1962		
Kunmingaspis Chang, 1964		
Meitania Yuan, 1978		
M. (*Promeitania*) Yuan et Zhao, 1997		
Metabalangia Qian et Yuan, 1980		
Microryctocara Sundberg et McCollum, 1997		
Nangaoia Zhou, 1974		
N. (*Gedongaspis*) Yuan et Zhao, 1997		
Nangaops Yuan et Sun, 1980		
Olenoides Meek, 1877		
Oryctocephalina Lermontova, 1940		
Oryctocephalites Resser, 1939		
Oryctocephaloides Yuan, 1980		
Oryctocephalops Lermontova, 1940		
Oryctocephalus Walcott, 1886		
Ovatoryctocara Tschernysheva, 1962		
Pagetia Walcott, 1916		
Paramgaspis Yuan et Zhao, 1997		
Parashuiyuella Yuan et Zhao, 1997		
Peronopsis Hawle et Corda, 1847		
Probowmania Kobayashi, 1935		
Pro. (*Gunnia*) Gatehouse, 1968		
Pro. (*Mufushania*) Lin, 1965		
Protoryctocephalus Zhou, 1974		
Qiannanagraulos Yuan et Zhao, 1997		
Redlichia Cossmann, 1902		
Sanwania Yuan, 1980		
Temnoura Resser et Endo, 1935		
Wuxunaspis Yuan, 1980		
Xingrenaspis Yuan et Zhou, 1980		
Yuehsienszella Chang, 1957		

最初凯里组自上而下分为 3 个三叶虫带:*Danzhaiaspis-Xingrenaspis* 带,*Wuxunaspis* 带和 *Nangaops* 带(张文堂等,1979),尔后又分为 4 个带:*Kootenia jialaoensis* 带,*Orycto-cephalus-Xingrenaspis* 带,*Wuxunaspis* 带和 *Nangaops-Kunmingaspis* 带(周志毅等,1980),其后又有一些作者对以上的分带作了一些小的变更,如将 *Nangaops-Kunmingaspis* 带改为 *Bathynotus-Nangaops* 带(赵元龙等,1993)。

Bathynotus-Nangaops 带的定义是,以 *Balangcunaspis* 属的首次出现作为此带的底界,以 *Nangaops* 的绝灭作为此带的顶界,*Redlichia* 以及 *Bathynotus* 是这个带的特征属。此外尚有 *Chittidilla* (*Diandongaspidella*), *Eokaotaia*, *Danzhaina*, *Nangaoia* (*Gedongaspis*), *Kunmingaspis*, *Olenoides*, *Microryctocara*, *Ovatoryctocara*, *Oryctocephalops*, *Oryctocephalites*, *Protoryctocephalus*, *Burlingia*, *Parashuiyuella*, *Probowmania*, *Pro*. (*Mufushania*), *Qiannanagraulos*, *Sanwania*, *Yuehsienszella* 等,此带代表凯里组底部 25—40m 青灰色、钙质、砂质泥岩,夹青灰色钙质页岩和薄层泥质灰岩的一段地层。

以 *Pagetia gaotanensis* Zhang, S.G.的出现作为 *Wuxunaspis* 带的底界,以 *Wuxunaspis* 属的消失作为此带的顶界。从属的组成来看,此带既有从 *Bathynotus-Nangaops* 带内上延的分子,如 *Kunmingaspis*, *Danzhaina*, *Probowmania* (*Mufushania*), *Microryctocara*, *Nangaoia* (*Gedongaspis*), *Olenoides*, *Sanwania* 等,又有一些 *Danzhaiaspis-Xingrenaspis* 带内的先驱分子,如 *Xingrenaspis*, *Pagetia* 等,还有一些是本带内特有的分子,如 *Wuxunaspis*, *Meitania* (*Promeitania*)等,此带代表凯里组中下部 0.5—30m 青灰色钙质粉砂质泥岩的一段地层。也代表我国下寒武统顶部不含 *Redlichia* 的最晚期的一个化石带。

以 *Oryctocephalus indicus* (Reed)的出现作为 *Danzhaiaspis-Xingrenaspis* 带的底界,而以 *Kaotaia* 属的消失作为此带的顶界。此带内三叶虫的分异度极高,并出现有球接子 *Peronopsis* 和凯里生物群。常见的属还有 *Xingrenaspis*, *Kaotaia*, *Jiumenia*, *Kailiella*, *Danzhaiaspis*, *Oryctocephalites*, *Oryctocephaloides*, *Metabalangia*, *Microryctocara*, *Oryctocephalina*, *Burlingia*, *Paramgaspis*, *Meitania*, *Kütsingocephalus*, *Pianaspis*, *Temnoura*, *Probowmania* (*Gunnia*), *Probowmaniella*, *Chengshanaspis* 等。此带代表凯里组中上部 80—190m 灰绿、黄绿色钙质、粉砂质泥岩夹页岩一段地层。

Kootenia jialaoensis 带现更名 *Olenoides jialaoensis* 带,因为此种尾部没有尾边缘沟,尾肋部的肋沟,间肋沟都很发育,应归于 *Olenoides* 属。此带内的三叶虫属大部分是由 *Danzhaiaspis-Xingrenaspis* 带上延的分子,如 *Peronopsis*, *Pagetia*, *Oryctocephalites*, *Oryctocephalus*, *Olenoides* 等。此带代表凯里组顶部 30—45m 浅灰、灰色中薄层泥质灰岩、生物碎屑灰岩。

3　凯里组与国内同期地层对比(表Ⅱ)

关于凯里组与国内同期地层对比,以往许多作者都有过详细的论述(张文堂等,1979;周志毅等,1980;卢衍豪等,1982;刘永耀等,1984;林焕令等,1990;赵元龙等,1993)。凯里组是一个跨下、中寒武统的地层单位,目前已基本达成共识。但有关滇东的陡坡寺组许多作者仍然坚持其时代为中寒武世早期(张文堂等,1970,1980;林焕令等,1990;罗惠麟等,1993,

1994)。其主要理由是在陡坡寺组内从未找到过早寒武世的标准化石 *Redlichia*。然而,在贵州台江八郎剖面及湖北京山县惠亭山、钟祥县火石沟剖面上 *Redlichia* 与 *Chittidilla*, *Kunmingaspis* 共生(赵文龙等,1993;袁金良等,1997;孙振华,1982);在安徽淮南老鹰山剖面上毛庄组底部则有陡坡寺组下部所产的 *Paragraulos* 与 *Redlichia* 混生(袁金良等,1999)。

表Ⅱ 凯里组与国内同期地层的对比

Correlation chart of the Kaili Formation with its synchronous strata in China

		N-China	E-Yunnan	SE-Guizhou	Central Guizhou
Amgan Stage	Hsuchuangia-Ruichengella Zone	*Bailiella-Lioparia* Z. *Poriagraulos* Z. *Inouyops* Z. *Metagraulos* Z. *Sunaspis-Sunaspidella* Z. *Sinopagetia pagetia jinnanensis* Z. *Ruichengaspis* Z. *Hsuchuangia-Ruichengella* Z.	Lower part of Shuanglungtan Formation	Jialao Formation	Shilengshui Formation
				Kaili Formation	
	Shantungaspis-Qiaotouaspis Zone	*Shantungaspis* Z. *Probowmaniella* Z. *Qiaotouaspis-Paragraulos* Z.	Douposi Formation		Kaotai Formation
Meishucunian Stage					Tsinghsutung Formation
	Bonnia-Redlichia Zone	*Bonnia-Tingyuania* Z. *Redlichia chinensis* Z.	Lungwangmiao Formation	Wuxun Formation	

以上事实足以证明陡坡寺组下部产 *Chittidilla*, *Kunmingaspis*, *Paragraulos* 的一段地层,时代应为早寒武世晚期。卢衍豪等(1988)通过深入研究毛庄组的三叶虫,也发现毛庄组底部的褶颊虫类三叶虫与 *Redlichia* 共生,因此毛庄组也是跨下、中寒武统的地层单位。关于凯里组的顶界,由于最近在台江八郎凯里组的中上部发现了毛庄组顶部至徐庄组底部以往统称为 *Hsuchuangia* 而今改为 *Temnoura* 的三叶虫,而使凯里组与华北毛庄组、徐庄组的对比有了更直接的证据。*Hsuchuangia* 与 *Temnoura* 的头部十分相似,其尾部也都有一对由肋部向后侧延伸的尾侧刺,两者的主要区别是 *Temnoura* 头盖的前边缘平凸或圆凸而不像 *Hsuchuangia* 平或向前上方翘起,此外,眼脊伸达头鞍前侧角,在两侧刺之间尾部后缘平直或向前略凹不像 *Hsuchuangia* 的尾部后缘向后拱曲,尾肋沟均匀地向侧后方弯曲,而不像 *Hsuchuangia* 后部的尾肋沟向侧前方弯曲。

因为 *Temnoura* 与 *Kaotaia*, *Kütsingocephalus* 等三叶虫混生,因此产 *Kaotaia*, *Kütsingocephalus* 的陡坡寺组、高台组的顶界应略高于毛庄组的顶界。凯里组顶部灰岩段 *Olenoides jialaoensis* 带是在产 *Kaotaia*, *Temnoura*, *Kütsingocephalus* 等三叶虫之上,其中

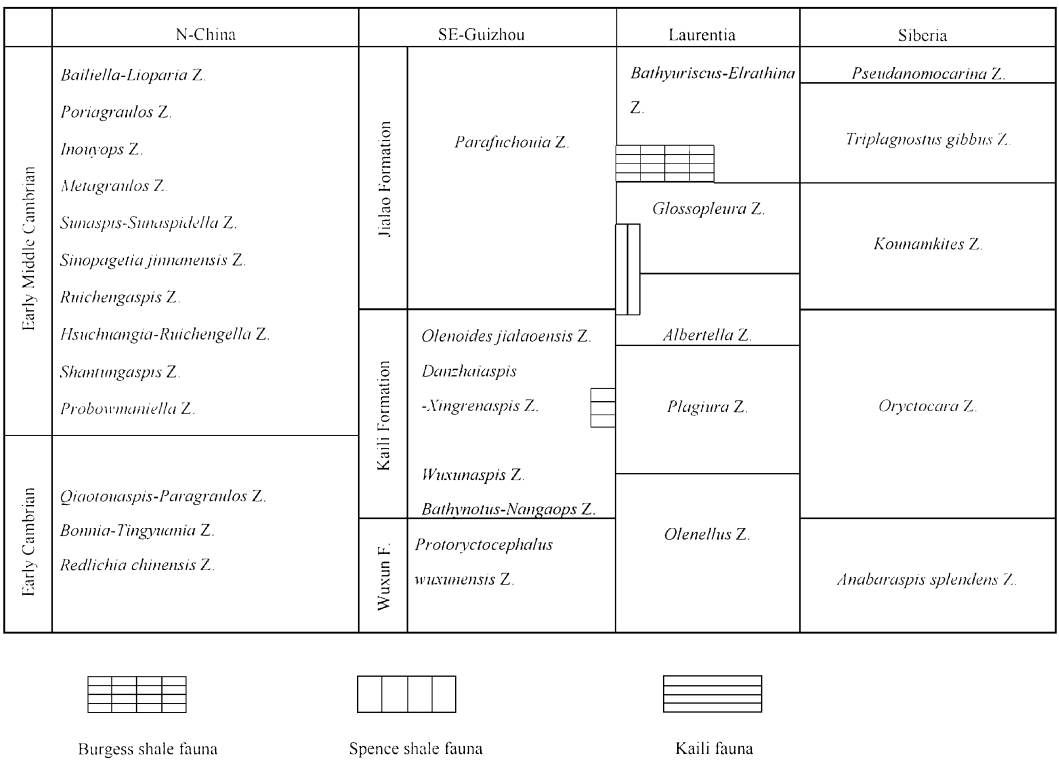
所产的 *Oryctocephalus*, *Oryctocephalites* 的一些种如 *Oryctocephalites guizhouensis* Lu et Chien, 1974, *Oryctocephalus* cf. *orientalis* Saito, 1934 与其下面层位所产的头鞍明显向前收缩的 *Oryctocephalus indicus* (Reed)明显不同。此外,另外一些置于 *Xingrenaspis* 属内的种如 *Xingrenaspis quadratus* Yuan et Zhou, 1980, *X. curvus* (Zhou, 1974),其尾部中轴短而宽,尾边缘极窄,与真正的 *Xingrenaspis* 尾部不同。

类似的属种同样见于辽东半岛南部复县磨盘山徐庄组下部(南润善等,1982)。因此,*Olenoides jialaoensis* 带可能略高于华北徐庄组的 *Hsuchuangia-Ruichengella* 带。

4　凯里组与国外同期地层对比(表Ⅲ)

表Ⅲ　凯里组与北美和西伯利亚同期地层的对比

Correlation chart of the Kaili Formation with its synchronous strata in Laurentia and Siberian platform



在北美早寒武世晚期至中寒武世早期可以分成 5 个三叶虫化石带。早寒武世晚期 *Olenellus* 带的顶部产 *Bathynotus holopygus*, *Oryctocephalites* sp. (Palmer, 1998, p. 653)以及 *Oryctocephalites palmeri* (Sundberg and McCollum, 1998, p. 1068),与此类似的三叶虫 *Bathynotus*, *Oryctocephalites* 已在 *Bathynotus-Nangaops* 带内发现,因此凯里组下部可与北美 *Olenellus* 带上部对比。*Plagiura* 带内产 *Oryctocephalus indicus* (Reed), *Micromyctocara nevadensis* (Sundberg and McCollum, 1998, p. 1069),而相同和类似种产于凯里组 *Danzhaiaspis-Xingrenaspis* 带,因此凯里组中上部可与北美 *Plagiura* 带对比。

Albertella 带内产 *Oryctocephalus primus* Walcott，1886 与凯里组顶部所产的 *Oryctocephalus* cf. *orientalis* Saito，1934 十分相似，两者都具有近乎平行的头鞍；此外 *Albertella* 带内所产的 *Oryctocephalites typicalis* Resser (Palmer and Halley，1979，pl.13，figs.1—4)与凯里组顶部所产 *Oryctocephalites guizhouensis*(卢衍豪等，1974，100—101 页，图版 39，图 7；尹恭正等，1978，438 页，图版 153，图 18)可能为同一个种。因此，代表凯里组顶部的 *Olenoides jialaoensis* 带至少可与 *Albertella* 带下部相当。有关凯里动物群时代与布尔吉斯页岩动物群对比问题，由于后者产于 Stephen 组，而 Stephen 组位于 *Bathyuriscus-Elrathina* 带中下部，*Bathyuriscus-Elrathina* 带内产有 *Tonkinella*，*Triplagnostus gibbus* (Linnarsson)，*Tri. intermedius* (Tullberg)等三叶虫，而我国华北及东北南部的 *Poriagraulos* 带至 *Bailiella-Lioparia* 带内亦产有 *Tonkinella* 以及 *Triplagnostus sinicus* (Lu，1957)等三叶虫。根据 Robison (1982)的意见，后一个种与 *Triplagnostus intermedius* 可能为同种，因此 *Bathyuriscus-Elrathina* 带可与我国 *Poriagraulos* 带至 *Bailiella-Lioparia* 带对比。

关于与斯潘塞(Spence Shale)页岩动物群对比问题，由于我国在过渡区相当的地层内还未发现有关 Oryctocephalidae 科和球接子类三叶虫，因此还不能直接进行对比。但 Spence 页岩从 *Albertella* 带上部至 *Glossopleura* 带内所产的一些三叶虫，如 *Kootenia*，*Pagetia* 与华北徐庄组中上部所产 *Kootenia*，*Sinopagetia* 相似，因此 Spence 页岩大致相当于我国华北的 *Sinopagetia jinnanensis* 带至 *Inouyops* 带。

根据 Savitzky 等(1972)意见，西伯利亚地台早期中寒武世地层可划分为 4 个三叶虫带：*Pseudanomocarina* 带，*Triplagnostus gibbus* 带，*Kounamkites* 带和 *Oryctocara* 带(表Ⅲ)。其中 *Oryctocara* 带的下部产有 *Oryctocara angusta* Tschernysheva，*Oryctocephalops frischenfeldi* Lermontova 等三叶虫，与凯里组下部 *Bathynotus-Nangaops* 带内所产 *Ovatoryctocara* sp.，*Oryctocephalops* sp.(袁金良等，1997)十分相似，因此，*Oryctocara* 带下部大致与凯里组下部相当；*Oryctocara* 带中上部产有 *Oryctocephalus limbatus* Tschernysheva 与凯里组中上部所产 *Oryctocephalus* sp. (sp. nov)也十分相似。此外，*Oryctocara* 带中上部所产球接子 *Peronopsis recta* Pokrovskaya et Jegorova，*Peronopsis* aff. *inarmata* Hutchinson 分别与凯里组中上部所产 *Peronopsis taijiangensis* Huang et Yuan，1994 和 *Peronopsis* cf. *majiangensis* Lu et Qian 极为相似，因此，凯里组中上部应大致与 *Oryctocara* 带中上部相当。

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ON THE KAILI FORMATION

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Key words: Kaili Formation, zonation and correlation, SE-Guizhou

Summary

The Kaili Formation bearing the Kaili fauna crops out in a continuous NE-SW outcrop belt from Danzhai County via Taijiang, Yuping to Tongren in SE-Guizhou, S-China for about 370km (Zhao *et al*., 1993, fig. 1). This Formation underlying uppermost part dolomite of Wuxun Formation and overlying lowermost part black carbonaceous thin-bedded limestone intercalated with carbonaceous shale of the Jialao Formation includes lithologically three parts: the lower part about 25—70m thick is composed of grey, dark grey calcareous sandy mudstone intercalated with dark grey calcareous shale and thin bedded limestone; the middle part about 80—190m thick is made up of greenish grey, grey to yellowish green calcareous silty mudstone intercalated with grey shale and the upper part about 30—45m in thickness consists of light grey thin bedded argillaceous limestone and bioclastic limestone. The Kaili Formation can be divided four trilobite Zones in ascending order: 1. *Bathynotus-Nangaops* Zone, 2. *Wuxunaspis* Zone, 3. *Danzhaiaspis-Xingrenaspis* Zone, 4. *Olenoides jialaoensis* Zone. *Bathynotus-Nangaops* Zone is marked by the first appearance of *Balangcunaspis* Yuan et Zhao, 1997 as its lower limmit and by the extinction of *Nangaops* Yuan et Sun, 1980 as its upper limit. This zone is characterized by the presence of *Redlichia*, *Bathynotus*. The main components of the zone contain the following genera: *Chittidilla* (*Diandongaspidella*), *Eokaotaia*, *Danzhaina*, *Nangaoia* (*Gedongaspis*), *Kunmingaspis*, *Olenoides*, *Ovatoryctocara*, *Oryctocephalops*, *Protoryctocephalus*, *Oryctocephalites*, *Microryctocara*, *Burlingia*, *Parashuiyuella*, *Probowmania*, *Pro*. (*Mufushania*), *Qiannanagraulos*, *Sanwania*, *Yuehsienszella*, *Redlichia*, *Bathynotus*. *Wuxunaspis* Zone is defined by the first appearance of *Pagetia gaotanensis* Zhang, S. G., 1980 as its lower limit and by the disappearance of *Wuxunspis* Yuan, 1980 as its upper limit. This zone has the following features: 1. The typical Lower Cambrian trilobites *Redlichia*, *Bathynotus* disappear, 2. the main elements of this zone contain not only *Kunmingaspis*, *Danzhaina*, *Olenoides*, *Sanwania*, *Microryctocara*, *Probowmania* (*Mufushania*), *Nangaoia* (*Gedongaspis*) of *Bathynotus-Nangaops* Zone, but

Pagetia, *Xingrenaspis* of *Danzhaiaspis-Xingrenaspis* Zone. *Danzhaiaspis-Xingrenaspis* Zoneis marked by the first apperanace of *Oryctocephalus indicus* (Reed, 1910) as its lower limit and by the disappearnace of *Kaotaia* Lu, 1962 as its upper limit. This zone exhibits not only a relativeyly higher diversity of trilobite genera, but soft-body bearing Kaili biota. About twenty trilobite genera (subgenera) have been found, e.g. *Xingrenaspis*, *Kaotaia*, *Jiumenia*, *Kailiella*, *Danzhaiaspis*, *Meitania*, *Kuetsingocephalus*, *Oryctocephalus*, *Oryctocephalites*, *Oryctocephaloides*, *Oryctocephalina*, *Metabalangia*, *Microryctocara*, *Burlingia*, *Paramgaspis*, *Nangaoia*, *Pianaspis*, *Temnoura*, *Probowmania* (*Gunnia*), *Chengshanaspis*, *Peronopsis*. *Olenoides jialaoensis* Zone is marked by the presence of *Olenoides jialaoensis* (Lu et Chien, 1978). The elements of this zone consist of those genera extending from *Danzhaiaspis-Xingrenaspis* Zone, e.g. *Peronopsis*, *Oryctocephalus*, *Oryctocephalites*, *Olenoides*, *Pagetia*. The stratigraphical distribution of trilobite genera (subgenera) from the Kaili Formation is given on the table Ⅰ. The tentatively correlation of Kaili Formation with its synchronous strata in China is shown in table Ⅱ. and the tentatively correlation of the Kaili Formation with its synchronous strata in Laurentia and Siberian platform is given on table Ⅲ.

DESCRIPTION OF NEW SPECIES

Family Crepicephalidae Kobayashi, 1935

Genus *Temnoura* Resser and Endo in Kobayashi, 1935

1935 *Temnurus* Resser and Endo in Kobayashi, p.271.

1935 *Temnura* Resser and Endo in Kobayashi, p.278.

1937 *Temnoura* Resser and Endo, p.294.

1982 *Asteromajia* Nan et Chang, p.33.

1987 *Temnoura* Zhang et Jell, p.247.

Type species: *Temnoura granosa* Resser et Endo in Kobayashi, 1935

Assigned species: *Temnoura granosa* Resser et Endo, 1935, *T. duplicata* (Nan and Chang, 1982), *T. huoshanensis* (Zhang and Wang, 1985), *T. mesembrina* sp.nov.

Revised diagnosis: Cranidium with convex anterior border and distinct border furrow; glabella convex, truncated conical, with three pairs of short lateral furrows; palpebral lobe medium in size, placed slightly behind mid-glabellar level, thorax of 12 segments; pygidial axis convex, tapering gradually backward, six axial rings and a small terminal piece distinct; 5—6 pairs of pleural furrows well impressed, curved backward, a pair of broad, short pygidial spines extending backward; posterior margin slightly to strongly arched forward, surface of exoskeleton granular or pitted.

Discussion: In general configuration of cranidium *Temnoura* bears the closest resembrance to *Hsuchuangia* Lu et Zhu in Qiu *et al*., 1983, with *Kochaspis hsuchuangensis* Lu, 1952 as the type species, however, it differs from the latter mainly in having more convex anterior border, deeper anterior border furrow, longer pygidium with deeper, curving backward pleural

furrows on pleural area of pygidium, slightly to strongly arched forward posterior pygidial margin instead of strongly arched backward posterior margin in the latter. Because of the presence of convex anterior border and deeper anterior border furrow we here consider *Asteromajia* Nan et Chang synonymous with *Temnoura*.

Age and distribution: Early Middle Cambrian; China.

***Temnoura mesembrina* sp. nov.**

(Pl. Ⅱ, figs. 10, 11)

Diagnosis: Exoskeleton elongated oval, length of ratio of cephalon, thorax, pygidium about 1.8∶2.5∶1; cephalon with moderately long genal spine; glabella with broadly rounded anterior margin and 3 pairs of short lateral furrows; anterior border wide and convex; preglabellar field narrow; eye ridge distinct; palpebral lobe medium in size, placed slightly behind mid-glabellar level; anterior branches of facial sutures divergent forward; thorax of 12 segments, pleural spines moderately long, extending backward; pygidial axis convex, with 6—7 axial rings; pleural area with 5 pairs of pleural furrows; a pair of marginal spines rather broad and long, curved backward and inward; the surface of exoskeleton pitted.

Comparison: In general configuration of cranidium and pygidium the new species is quite similar to *Temnoura huoshanensis* Zhang et Wang from uppermost part of Maochuang Formation to lowest part of Hsuchuuang Formation of Huoshan, Shanxi and Mianchi, western Henan (Zhang and Wang, 1985; p. 362—363, pl. 110, figs. 16—18; Zhang *et al.*, 1995; p. 13, 39, pl. 12, fig. 9), however, it can be distinguished from the latter chiefly by longer pygidial axis with 6—7 axial rings, longer pygidial marginal spines and the pitted surface of the exoskeleton.

Occurrence: *Danzhaiaspis-Xingrenaspis* Zone; Balang, Taijiang, SE-Guizhou.

图 版 说 明

编号 NIGP 130654—130664 标本采自贵州省丹寨县南皋剖面，NIGP130648—130652 标本采自贵州省台江县八郎剖面，保存在中国科学院南京地质古生物研究所，其余编号标本采自贵州省台江县八郎剖面，保存在贵州工业大学资源工程系。

图 版 Ⅰ

1. *Balangcunaspis transversus* Yuan et Zhao, 1997

头盖，×15，野外号：GTB8，登记号：NIGP 130648；*Bathynotus-Nangaops* Zone.

2. *Nangaops elongatus* Yuan et Sun, 1980

背壳，×3，野外号：GTB 9-1-321a，登记号：NIGP 130649；*Bathynotus-Nangaops* Zone.

3. *Bathynotus gaotanensis* Zhang et Li, 1984

背壳，×3，野外号：GTB 6-3-25，登记号：GK4402；*Bathynotus-Nagaops* Zone.

4. *Redlichia* sp.

幼虫头盖，×10，野外号：GTB 9-0，登记号：NIGP 127373；*Bathynotus-Nangaops* Zone.

5. *Wuxunaspis deltoidea* Yuan, 1980

头盖,×8,野外号:BM-8-3-23,登记号:NIGP 130650; *Wuxunaspis* Zone.

6. *Oryctocephalus indicus* (Reed, 1910)

头盖,×5,野外号:BM 8-5-41,登记号:GK0682; *Danzhaiaspis-Xingrenaspis* Zone.

7. *Xingrenaspis xingrenensis* Yuan et Zhou, 1980

背壳,×3,野外号:BM10,登记号:NIGP 130651; *Danzhaiaspis-Xingrenaspis* Zone.

8. *Danzhaiaspis quadratus* Yuan et Zhou, 1980

背壳,×4,野外号:GTB 15-8-1;登记号:GK1243; *Danzhaiaspis-Xingrenaspis* Zone.

图 版 Ⅱ

9. *Kaotaia globosa* Chang et Zhou, 1974

头盖,×2,野外号:M22-2-148,登记号:NIGP.130652; *Danzhaiaspis-Xingrenaspis* Zone.

10,11. *Temnoura mesembrina* sp.nov.

10.头盖,正模标本(holotype), ×3,野外号:BM22-169,登记号:NIGP 130653

11.头盖,×4,野外号:M19-2-98,登记号:NIGP 130654; *Danzhaiaspis-Xingrenaspis* Zone.

12—14. *Olenoides jialaoensis* (Lu et Chien, 1978)

12.头盖,×4,野外号:丹 93,登记号:NIGP 130655;

13.尾,×3,野外号:丹 93,登记号:NIGP 130656;

14.尾,×4,野外号:丹 93,登记号:NIGP 130657; *Olenoides jialaoensis* Zone.

15,16. *Pagetia danzhaiensis* Zhang, S.G., 1980

15.头盖,×20,野外号:丹 93,登记号:NIGP 130658

16.尾,×20,野外号:丹 93,登记号:NIGP 130659; *Olenoides jialaoensis* Zone.

17. *Oryctocephalus* cf. *orientalis* Saito, 1934

头盖,×10,野外号:丹 93,登记号:NIGP 130660; *Olenoides jialaoensis* Zone.

18—21. *Xingrenaspis* (?) *quadratus* Yuan et Zhou, 1980

18.尾,×15,野外号:丹 92,登记号:NIGP 130661;

19.头盖,×10,野外号:丹 92,登记号:NIGP 130662;

20.头盖,×10,野外号:丹 93,登记号:NIGP 130663;

21.头盖,×10,野外号:丹 93,登记号:NIGP 130664; *Olenoides jialaoensis* Zone.

Appendix: List of trilobite species in Kaili Formation with their modern taxonomic placement

Species name	New palcement
1. *Alokistocare curvus* Zhou, 1974	*Xingrenaspis*
2. *A. qinkouense* Zhou, 1974	*Kaotaia*
3. *Bathynotus kueichowennsis* Lu, 1964	
4. *B. gaotanensis* Zhang et Li, 1984	
5. *B. elongatus* Zhao, Gong et Huang, 1987	
6. *B. sinensis* Zhao, Huang et Gong, 1990	
7. *Burlingia ovata* Zhou et Yuan, 1980	
8. *Chengshanaspis conica* Yuan et Zhao, 1997	
9. *Chittidilla* (*Diandongaspidella*) cf. *diandongensis* Lu et Zhang, 1980	
10. *Ch.* (*D.*) *guizhouensis* Yuan et Zhao, 1997	
11. *Danzhaiaspis quadratus* Yuan et Zhou, 1980	
12. *D. latilimbatus* Yuan, 1980	
13. *D. brevis* Yuan, 1980	

14. *D.*(?) *sanwanensis* Yuan, 1980	
15. *D.*(*Nangaocephalus*) *vigilans* Yuan, 1980	*Danzhaiaspis*
16. *D.*(*N.*) *similis* Yuan, 1980	*Danzhaiaspis*
17. *Danzhaina longispina* Yuan et Zhao, 1997	
18. *D. denzhouensis* Yuan et Zhao, 1997	
19. *Ehmaniella* (?) *similis* Yuan, 1980	? *Xingrenaspis*
20. *Elrathina danzhaiensis* Zhou, 1974	*Nangaops*
21. *Eokaotaia gedongensis* Yuan et Zhao, 1994	
22. *E. longa* Yuan et Zhao, 1994	
23. *Eoptychoparia nangaoensis* Yuan, 1980	*Yuehsienszella*
24. *Eosoptychoparia guizhouensis* Yuan, 1980	*Eokaotaia*
25. *E. conica* Yuan, 1980	*Chengshanaspis*
26. *E. intermedia* Yuan, 1980	*Wuxunaspis*
27. *Euarthricocephalus* spp.	*Microryctocara*
28. *Jiumenia spinosa* Yuan, 1980	
29. *J. triangulata* Yuan, 1980	
30. *Kailiella angusta* Lu et Chien, 1974	
31. *Kaotaia globosa* Chang et Zhou, 1974	
32. *K. magna* (Lu, 1962)	
33. *K. transversa* Yuan et Zhao, 1994	
34. *Kootenia jialaoensis* Lu et Chien, 1978	*Olenoides*
35. *Majiangia majiangensis* Lu et Qian, 1983	*Meitania*
36. *Meitania similis* Yuan, 1980	
37. *M.*(*Promeitania*) *subcylindrica* Yuan et Zhao, 1997	
38. *Mengzia* sp	*Olenoides*
39. *Metabalangia yupingensis* Qian et Yuan, 1980	
40. *Modocia obscura* Yuan, 1980	*Chengshanaspis*
41. *Nangaoia megaceps* Zhou, 1974	
42. *N.*(*Gedongaspis*) *granulosa* Yuan et Zhao, 1997	
43. *N.*(*Gedongaspis*) *oblonga* Yuan et Zhao, 1997	
44. *Nangaops brevis* Yuan et Sun, 1980	
45. *N. elongatus* Yuan et Sun, 1980	
46. *N. latilimbatus* Yuan, 1980	
47. *N. rarus* Yuan, 1980	
48. *Olenoides abnormis* Yuan et Zhao, 1997	
49. *O. octaspinus* Yuan et Zhao, 1997	
50. *O. paraptus* Zhao, Ahlberg and Yuan, 1994	
51. *Onchocephalus* (?) *sanwanensis* Yuan, 1980	*Danzhaina*
52. *Oryctocephalina yui* Zhao, Ahlberg and Yuan, 1996	
53. *Oryctocephalites guizhouensis* Lu et Chien, 1974	
54. *Oryctocephaloides convexus* Yuan, 1980	
55. *O. elongatus* Yuan, 1980	

56. *Oryctocephalops* sp.
57. *O. tongrenensis* Lu et Qian, 1983 — *Oryctocephalus*
58. *Oryctocephalus indicus* (Reed, 1910)
59. *O. incurvus* Lu et Chien, 1974
60. *O.* cf. *orientalis* Saito, 1934
61. *Ovatoryctocara* sp.
62. *Pachyaspis* (*Danzhaina*) *lilia* Yuan, 1980 — *Danzhaina*
63. *Pagetia bilobata* Lu et Chien, 1978
64. *P. danzhaiensis* Zhang, S.G., 1980
65. *P.* cf. *dayongensis* Liu, 1982
66. *P. salva* Lu et Qian, 1980
67. *P. taijiangensis* Yuan et Zhao, 1997
68. *Paraantagmus* (*Balangcunaspis*) *subcylindricus* Yuan et Zhao, 1997 — *Balangcunaspis*
69. *P.* (*B.*) *transversus* Yuan et Zhao, 1997 — *Balangcunaspis*
70. *Paramgaspis guizhouensis* Yuan et Zhao, 1997
71. *Parashuiyuella sinensis* Yuan et Zhao, 1997
72. *Peronopsis gedongensis* Huang et Yuan, 1994
73. *P. majiangensis* Lu et Chien, 1974
74. *P. taijiangensis* Huang et Yuan, 1994
75. *Probowmania balangensis* Yuan et Zhao, 1997
76. *Pr.* (*Gunnia*) sp.
77. *Pr.* (*Mufushania*) *latilimbata* Yuan et Zhou, 1980
78. *Probowmaniella lata* Yuan, 1980 — *Probowmania* (*Gunnia*)
79. *Protoryctocephalus* sp.
80. *Qiannanagraulos orientalis* Yuan et Zhao, 1997
81. *Redlichia coniformis taijiangensis* Guo et Zhao, 1998
82. *Sanwania luna* Yuan, 1980
83. *S. prima* Yuan et Zhao, 1997
84. *Temnoura mesembrina* sp. nov.
85. *Wuxunaspis* (?) *deflecta* Yuan, 1980
86. *W. deltoidea* Yuan, 1980
87. *W.* (?) *guizhouensis* Yuan, 1980
88. *Xingrenaspis brevis* Yuan, 1980
89. *X. elongatus* Yuan et Zhou, 1980
90. *X. jialaoensis* Yuan et Zhou, 1980
91. *X. politus* Lu et Qian, 1983
92. *X. quadratus* Yuan et Zhou, 1980
93. *X. rectangularis* Yuan et Zhou, 1980
94. *X. xingrenensis* Yuan et Zhou, 1980

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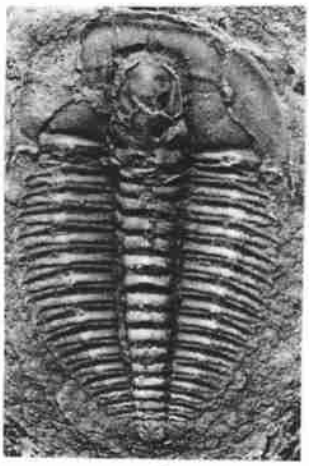

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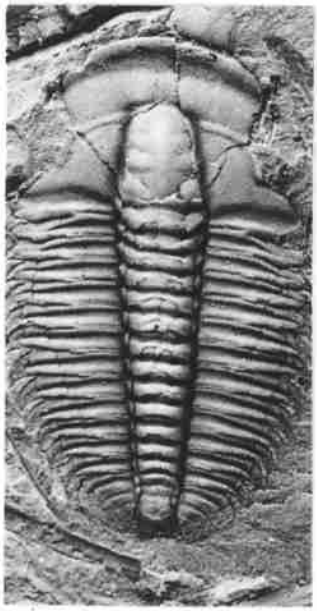

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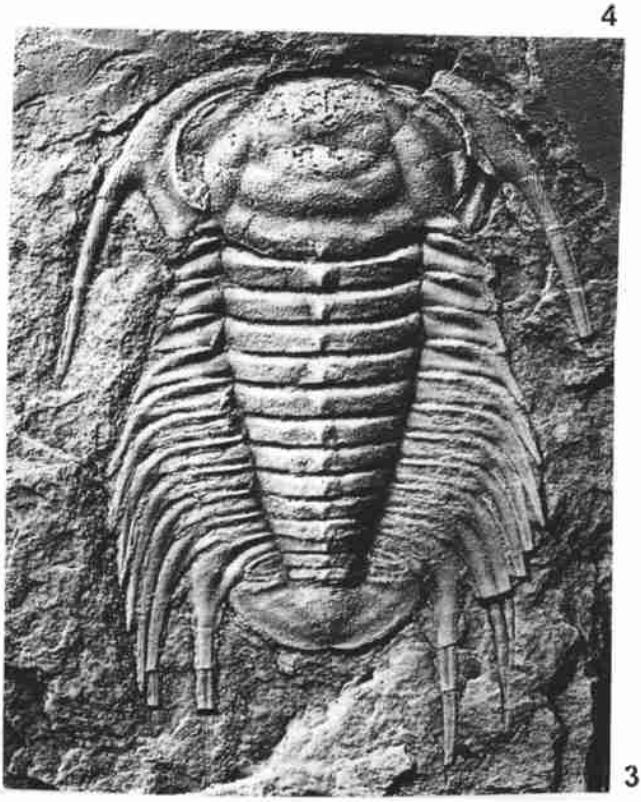

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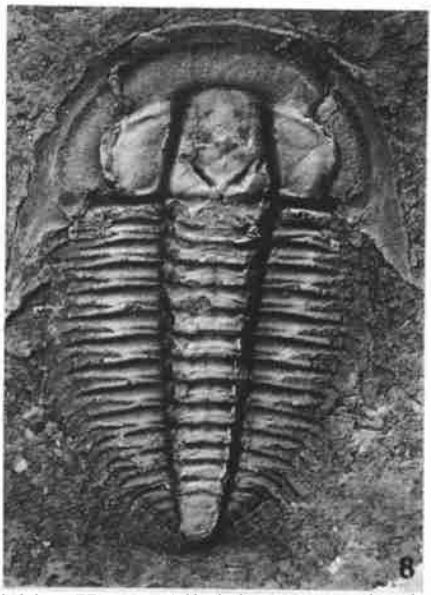

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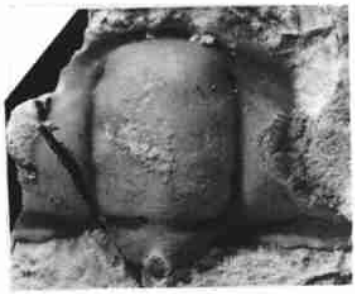

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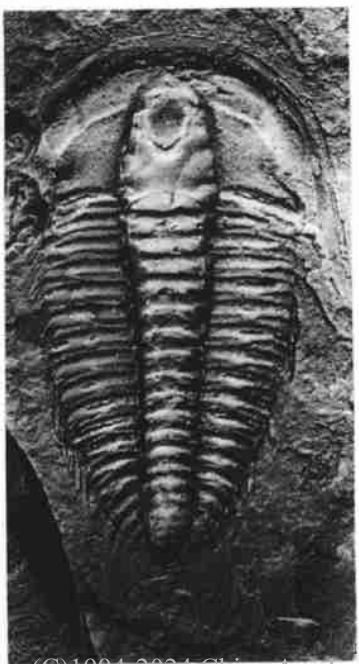

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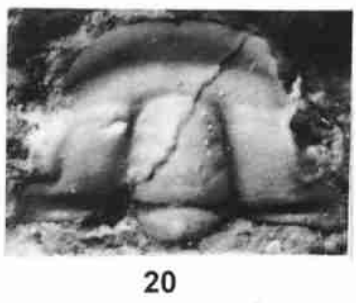

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