

贵州中寒武世凯里生物群中的 蠕形动物化石^{*}

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提要 描述了凯里生物群中的蠕形动物 *Ottoia*, *Maotianshanian*, *Palaeoscolex*, *Circocoscma*[?] 及 *Selkirkia*。这些软躯体的蠕虫化石在凯里生物群中都是首次发现。其中 *Ottoia* 也发现于布尔吉斯页岩生物群, *Maotianshanian*, *Circocoscma*[?] 则见于澄江生物群, 而 *Palaeoscolex* 则从澄江生物群至布尔吉斯页岩生物群中都有保存, 这是凯里生物群处于承前启后位置的又一证据。蠕形动物的发现, 增加了凯里生物群软躯体化石内容, 反映了凯里生物群是典型的布尔吉斯页岩生物群。

关键词 凯里生物群 蠕形动物 鳃曳动物 软躯体化石 寒武纪

蠕形动物是凯里生物群的组成部分(赵元龙等, 1994), 但属种少。经过不断采集, 凯里生物群中的蠕形类化石增加很多, 除了本文描述的 5 属 *Ottoia* Walcott, *Palaeoscolex* Whittard, *Circocoscma*[?] Hou et Sun, *Selkirkia* Walcott, *Maotianshanian* Sun et Hou 等外, 还有一些蠕形动物尚未研究。

按分类定义, 蠕形动物不是分类单位, 仅是指一些多门类、构造差异显著而又不具硬骨骼的蠕形状软躯体动物, 主要包括具体腔的环节动物、螯门、星虫门、鳃曳动物、帚虫动物、毛颚动物、无体腔及假体腔的纽形动物和扁形动物、袋虫动物等。由于这些动物很难保存为化石, 即使保存为化石, 也难保存其全部特征, 所以蠕形动物的分类学研究相当困难。

尽管早期后生软躯体生物群中的蠕虫动物不断被发现和研究(Walcott, 1911; Resser, 1939; Robison, 1969; Glaessner, 1979; 罗惠麟、张世山, 1986; 孙卫国等, 1987; 侯先光等, 1988; 林天瑞, 1996; Hou and Bergström, 1994; Conway Morris and Robison, 1986, 1988), 其分类仍有困难, 纲以上隶属关系经常变化, 出现不同的看法。例如陈均远将 *Palaeoscolex* 置于鳃曳动物门中(陈均远等, 1996), Hou 和 Bergström 则认为古蠕虫不具真正的体腔而置于假体腔的线形动物门中(Hou and Bergström, 1994)。

本文所描述的 5 属蠕形动物化石本身均具有吻和躯干, 不同的是 *Selkirkia* 的躯干藏于管内(Walcott, 1911; Conway Morris, 1977)。由于这些蠕虫都具有鳃曳动物(priapulids)类似

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的吻部构造,目前大多数学者都将这类化石作为鳃曳动物看待(Conway Morris, 1997)。

凯里生物群多属蠕形动物化石的发现及近期其他具软躯体化石明显增加,说明凯里生物群是一个典型的布尔吉斯生物群,即特异埋藏的化石生物群。

1 属种描述

鳃曳动物门 Priapulida

奥托亚虫科 Ottoidae Walcott, 1911

奥托亚虫 *Ottoia* Walcott, 1911

奥托亚虫(未定种) *Ottoia* sp.

(图版 I, 图 4; 图 II, 图 6, 7)

材料 1 块两条虫体互相叠压的正模标本及 1 块虫体 b 的副模标本。

描述 个体为弯曲的筒形,中部膨大并向侧外拱突。未见吻部构造, a 个体躯干长度超过 50 mm, 中部最大宽度达 7 mm。外体环节保存清楚, 中部体环宽度(纵向)最大, 达 1.1 mm。两端部分仅 0.7 mm。环脊明显凸起, 常常由两根细脊紧密排列而成。环节表面常有 5—7 条波状弯曲的横纹装饰(图版 II, 图 7)。未见消化肠道。

讨论及比较 奥托亚虫(*Ottoia*)是 Walcott 于 1911 年建立的属, 以加拿大不列颠哥伦比亚省 President 山脊北的 Otto 小溪命名, 并以此属建立奥托亚虫科, 置于环节虫类(annelids)(Walcott, 1911)。

建属时, Walcott (1911)并未给属下定义, 模式种 *O. prolifica* 描述也简单。Conway Morris (1977)据大量标本, 详尽、系统地研究了奥托亚虫, 其主要属征归纳如下:“外形长筒形, 身体两侧对称, 可分为体前的吻及具环节的躯干, 吻上有口及钩、刺、针形装饰物。具消化道、肌痕”, 并置于鳃曳动物门中。凯里的标本与产于布尔吉斯页岩中的奥托亚虫的模式种 *O. prolifica* Walcott (Walcott, 1911, p. 128—129, pl. 19, figs. 1—3, 5; Conway Morris, 1977, pls. 1—14; text figs. 36—37)的躯干部分的外形、环节等特征很相似。由于凯里标本未见吻部及其它解剖构造, 暂作未定种。

古蠕虫纲 Palaeoscolecida Conway Morris et Robison, 1986

古蠕虫科 Palaeoscolecidae Whittard, 1953

古蠕虫属 *Palaeoscolex* Whittard, 1953

雷特克利菲古蠕虫 *Palaeoscolex ratcliffi* Robison, 1969

(图版 I, 图 1—3; 图 II, 图 4)

材料 1 块具正副模的虫体标本。

特征 个体较大, 虫体表面每厘米长度环节数少、乳突和小坑构造发育。

描述 虫体圆管状, 卷成圆环状, 长度约 64 mm, 体环最大宽度在中部, 约 3 mm。虫体表面具有明显的环节, 每厘米约有 35 环节。环节表面由 3—4 排的乳突及坑组成交错排列的装饰, 每排乳突及小坑约 40—50 个, 交替出现; 每个环节之间为环脊, 环脊窄而细, 微凸, 脊上有横向小坑(图版 I, 图 1—3)。头部、尾部比较窄。具有明显的黑色消化道, 宽约 0.4

mm。

讨论及比较 古蠕虫类是虫体表面具有乳突装饰的蠕虫(侯先光等, 1988)。自从 Whittard(1953)描述了英国 Tremadocian 期的标本, 建立 *Palaeoscolex* 后, 在美国犹他州、西班牙、澳大利亚的中寒武统(Robison, 1969; Conway Morris and Robison, 1986, 1988; Müller and Hinz-Schallreuter, 1993)、我国下寒武统(侯先光、孙卫国, 1988; Hou and Bergström, 1994; 林天瑞, 1995; Zhang and Pratt, 1996)也有发现。通过标本观察, 凯里标本虫体外表的装饰实际上并不仅仅是乳突状突起为主导的装饰, 而是由突起及凹坑组成的交错排列的装饰构造为特征(图版 I, 图 1—3), 这与美国中寒武统 Spence Shale 动物群中的 *Palaeoscolex ratcliffei* Robison (Robison, 1969, p. 1171—1172, pl. 138, figs. 1—2)极为相似, 两者均呈圆环状保存, 宽度几乎相等, 每厘米内的环节数近于一致, 装饰均由交错的突起及凹坑构成, 应为一个种。与云南澄江下寒武统澄江生物群的 *P. sinensis* Hou et Sun(侯先光、孙卫国, 1988, 图版 III, 图 1—4; Hou and Bergström, 1994, fig. 1)也有些相似, 区别在于后者虫体躯干宽度较窄, 乳突明显, 且每排乳突的数量较少。凯里标本与安徽淮南下寒武统的 *P. huainanensis* Lin(林天瑞, 1995, 图版 I, 图 1—4)的区别在于每排乳突小坑的数量较多, 而且乳突构造没有 *P. huainanensis* Lin 的规则。

环饰蠕虫? *Cricocosmia?* Hou et Sun, 1988

环饰蠕虫? (未定种) *Cricocosmia?* sp.

(图版 II, 图 1—3)

材料 仅有 1 块具正副模标本。

描述 虫体呈细管状。未见吻部构造, 仅见躯干, 虫体宽 1.2—1.6mm, 长约 30mm。躯干中部每毫米长度内有 3.2—3.5 个环节; 前后部环节较稀, 每毫米长度内只有 2.5 个左右环节。每个环节具有一对保存较差的环状突起, 与虫体压缩面的中线呈对称分布, 距内外侧尚有一定距离。虫体中部有一纵向灰色或黑色带状物, 为虫体的肠道系统。

讨论及比较 环饰蠕虫(*Cricocosmia*)为侯先光与孙卫国 1988 年根据澄江生物群的标本建立的一个蠕虫属(侯先光、孙卫国, 1988, 图版 I, 图 1—2)。在虫体外形、肠道系统方面与 *Palaeoscolex* 等没有大的差别。其主要特征是在虫体躯干上每一个体环上均具 1 对小的环形构造。凯里标本与模式种 *C. jinninensis* Hou et Sun(侯先光、孙卫国, 1988, 图版 I, 图 1—2; 插图 2—3)在主躯干外形、体环外形及纵向长度、环状突起等方面很相似, 区别是凯里标本个体较细, 部分环状突起不显著, 外侧环状突起近于圆环状, 加之标本少, 未见吻部构造, 故暂归 *Cricocosmia* 属, 并作未定种。

帽天山虫 *Maotianshania* Sun et Hou, 1987

帽天山虫(未定种) *Maotianshania* sp.

(图版 I, 图 6)

材料 仅有 1 块不完整的虫体躯干标本。

描述 未见吻。虫体小, 细长, 圆筒状, 弯曲且已压扁。躯干体长度超过 14mm, 宽约 16mm。躯干体分节, 每毫米长度内有 1—1.5 个环节, 体环之间为环脊, 突起明显。环节上

面未见明显装饰。

讨论及比较 帽天山虫(*Maotianshania*)为孙卫国、侯先光 1987 年据澄江生物群中的标本建立的蠕虫属(孙卫国、侯先光, 1987)。其主要特征为虫体细长, 具吻, 后端具尾刺。躯干分节, 体环上有凹坑, 具狭长消化道。凯里标本与 *M. cylindrica* Sun et Hou(孙卫国, 侯先光, 1987, 图版 I, 图 1—5; 图版 II, 图 1—8; 插图 1—2; Hou and Bergström, 1994, fig. 3)相比, 在个体形态、体环构造等方面均相似。但当前标本保存不完整, 未见吻部、消化道等构造, 而且标本仅有 1 块, 暂作未定种。

塞尔柯尔基亚虫科 *Selkirkiidae* Walcott, 1911

塞尔柯尔基亚虫 *Selkirkia* Walcott, 1911

维尔洛夫拜塞尔柯尔基亚虫(比较种) *Selkirkia* cf. *willoughbyi*

Conway Morris et Robison, 1988

(图版 I, 图 5; 图版 II, 图 5)

材料 1 块具正副模的标本。

描述 未见吻, 仅见锥柱形的管及消化道。管的最前端宽 4.4mm, 长 19.5mm, 管的两侧缓缓向后收缩, 至 $2/3$ 处, 向后收缩较快, 末端近于三角形。表面没有明显的纹饰。消化道前部分呈漏斗形, 向后收缩为细管状。

讨论及比较 塞尔柯尔基亚虫为 Walcott 以 *Orthotheca major* Walcott 1908 为模式, 据加拿大不列颠哥伦比亚省 Selkirk 山脊而命名(Walcott, 1911, p. 120)。虫体由吻及躯干两部分组成, 躯干于杯管之内。除了模式种 *S. major* 外, Walcott 还建立了另 2 个种。Conway Morris (1977) 将这些种归为一种 *S. columbia*, 并将其作为 *Selkirkia* 的模式种(Conway Morris, 1977, p. 33), 对属厘定的定义为: “虫体分为前部的具刺吻部和躯干, 吻局部倒转, 见口及刺、针等装饰物; 躯干于管内消化系统纵向分布, 比较直; 体腔不分节。”Conway Morris 和 Robison(1986)据美国犹他州 Spence Shale, Marjum Shale 和 Wheeler Shale 生物群中的标本新建了 1 个种 *S. willoughbyi*, 用以纪念古生物学家 R. H. Willoughby。其主要特征是吻部前部窄而长, 后部横宽; 消化道前部横宽(Conway Morris and Robison, 1988, p. 9—12, figs. 4, 5)。此外, 他们还确认了 Resser 于 1939 建立的种 *S. spencei* Resser, 此种是据两个近于平行的空管而建立的(Resser, 1939, pl. 1, figs. 34—35)。

凯里组的标本与 *S. willoughbyi* Conway Morris et Robison (Conway Morris and Robison, 1988, figs. 4, 5)的躯干外形及消化道形态相似, 因此这里将凯里的标本作为该种的比较种处理。

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WORMS FROM THE MIDDLE CMBRIAN KAILI BIOTA, GUIZHOU, PRC

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Key words: worms, Priapulida, Kaili Biota, Cambrian

Summary

Soft-bodied worms have been collected recently from the middle part of the Kaili Formation (Middle Cambrian), increasing the known diversity of the Kaili Biota. In addition to the five genera discussed in the present paper——*Ottoia* Walcott, 1911, *Palaeoscolex* Whittard, 1953, *Cricocosmia*? Hou et Sun, 1988, *Selkirkia* Walcott, 1911 and

Maotainshania Sun et Hou, 1987——the Kaili Biota also contains fossil worms that have not yet been identified. According to recent classifications, worms are not a true clade, but a polyphyletic group of soft-bodied organisms collectively showing a variety of body plans. Fossil worms consist mainly of coelomate phyla including Annelida, Echiuroidea, Sipunculoidea, Priapulida, Phoronida, Chaetognatha and phyla lacking a coelum or having a pseudocoelum as Nemertinea, Platyhelminthes and Aschelminthes. Because fossil worms tend to be poorly preserved, classification of these organisms is difficult.

Although soft-bodied fossil worms continue to be collected and studied (e.g. Walcott, 1911; Resser, 1939; Robison, 1969; Sun and Hou, 1987; Hou and Sun, 1988; Hou and Bergström, 1994; Conway Morris and Robison, 1986, 1988; Lin, 1995), their classification remains difficult, and relationships above the class level are fluid. For example, whereas Chen *et al.* (1996) assigned *Palaeoscolex* to priapulids, Hou and Bergström (1994) concluded that *Palaeoscolex* lacked a true coelom and assigned it to the pseudocoelomate group Nematomorpha (Hou and Bergström, 1994).

The present paper describes five fossil worm genera having a proboscis and an annulated trunk. In one of these genera, *Selkirkia*, the soft body was encased in a tube (Walcott, 1911; Conway Morris, 1977). The authors here accepted more recent opinion on position of the these worms and considered them as priapulid worms, because of the similar proboscises (Conway Morris, 1997).

Because fossil worms are abundant in the Kaili biota, the Kaili biota is a typical Burgess Shale-type biota.

DESCRIPTION OF SPECIES

Phylum Priapulida

Family Ottoidae Walcott, 1911

Ottoia sp.

(Pl. I, fig. 4; Pl. II, figs. 6, 7)

Material: One specimen consisting of two individuals (labelled 'a' and 'b').

Description: Body curved, cylindrical, expanded in the middle part, tapering gradually at each end. Proboscis not preserved. Trunk of 'a' over 50 mm long, 7 mm wide in the middle part. Trunk divided by annular ridges into numerous segments, with 9 segments in a distance of 10 mm in the middle part and 14 segments in a distance of 10 mm at each end of the body. Annular ridge convex, over 1 mm high, consisting of two small ridges. Each annular segment has 5 to 7 wavy, transverse lines that form a mesh-work ornament (Pl. II, fig. 7). Internal digestive organs not preserved.

Comparison: This specimen is similar to the type species, *O. prolifica* Walcott, 1911

(Walcott, 1911, p. 128—129, pl. 19, figs. 1—3, 5; Conway Morris, 1977, p. 5—6, pl. 1, fig. 1, text-fig. 36; pl. 2, fig. 7; pl. 12, fig. 6; Briggs *et al.*, 1994, p. 121—122, fig. 71) in the shape of the trunk and the annular ridges. However, because the anterior part lacks the proboscis and gut, the specimen is here referred to species indet.

Order Palaeoscolecida Conway Morris et Robison, 1986

Family Palaeoscolecidae Whittard, 1953

Genus *Palaeoscolex* Whittard, 1953

Palaeoscolex ratcliffei Robison, 1969

(Pl. I, figs. 1—3; Pl. II, fig. 4)

Material: A single complete individual and its counterpart.

Description: Single large, coiled, flattened specimen preserved in mudstone. If fully extended the specimen would measure approximately 64 mm long, with a maximum width in the middle part of the body of about 3 mm. Specimen exhibits obvious annular somites that number about 3.5 per 10 mm on average. Each somite bears 3—4 transverse rows of papillae and pits that form a conspicuous, mesh-work ornament (Pl. I, figs. 1—3). Each transverse row contains 40—50 papillae. Gut flattened and preserved as a dark band in the middle of the trunk.

Discussion and comparison: The specimen described here is very similar to *P. ratcliffei* Robison, 1969 (Robison, 1969, p. 1171—1172, pl. 138, figs. 1—2) from the Spence Shale (Middle Cambrian, Utah) in the shape and width of the body, the number of papillae, the minute gut, and the mesh-work ornament on the somites. The Kaili specimen differs from *P. sinensis* Hou et Sun, 1988 (Hou and Sun, 1988, p. 5—6, pl. III, figs. 1—4; Hou and Bergström, 1994, p. 112, fig. 1) from the Chenjiang Biota in having a wider body and weaker papillae and differs from *P. huainanensis* Lin (Lin, 1995, pl. I, figs. 1—4) from the Lower Cambrian of Anhui in having more papillae and pite on the somites.

Genus *Cricocosmia*? Hou et Sun, 1988

Cricocosmia? sp.

(Pl. II, figs. 1—3)

Material: A single complete individual and its counterpart.

Description: Body slender, cylindrical. Proboscis not preserved. Trunk over 30 mm long and 1.2—1.6 mm wide. Trunk divided by annular ridges, with 3.2 to 3.5 segments in a distance of 1 mm in the middle part and 2.5 segments in a distance of 1 mm (on average) at both ends. Each segment bears a pair of small, circular structures that are symmetrically arranged in two longitudinal rows on the surface of the trunk. Gut straight, simple, preserved as a dark median band.

Comparison: The Kaili specimen is similar to *C. jinningensis* Hou et Sun, 1988 (Hou

and Sun, 1988, p. 2–3, pl. 1, figs. 1–2; text-figs. 2–3) in the size and shape of the body and in the annulation on the surface. However, the body is more slender and the circular structures are not obvious. Also, the proboscis is not preserved and so it is here identified as *Cricocosmia*? sp.

Genus *Maotianshania* Sun et Hou, 1987

Maotianshania sp.

(Pl. I, fig. 6)

Material: A single specimen.

Description: Body small, elongate, originally cylindrical but flattened due to compression, proboscis not preserved. Trunk incomplete, over 14 mm long and 1.6 mm wide. Trunk usually shows 1.0–1.5 obvious annulated ridges in a distance of 1 mm.

Comparison: The Kaili specimen is similar to *M. cylindrica* Sun et Hou, 1987 (p. 300–302, pl. I, figs. 1–5; pl. II, figs. 1–8; text-figs. 1–2; Hou and Bergström, 1994, p. 12, fig. 3) in the shape of the body and the annulations on the surface. However, in the Kaili specimen the proboscis and gut are not preserved, and therefore it is here identified as *Maotianshania* sp.

Family Selkirkiidae Walcott, 1911

Genus *Selkirkia* Walcott, 1911

Selkirkia cf. *willoughbyi* Conway Morris et Robison, 1988

(Pl. I, fig. 5; Pl. II, fig. 5)

Material: Two specimens, both consisting of part and counterpart.

Description: Specimens consist of the tube only; proboscis and other soft tissues not preserved. Anterior part of the tube measures 4.4 mm wide and 19.5 mm long. Tube tapers gradually in the apical part, but at one-third of the total length from the apical end, the tube tapers rapidly. Gut bag-like at the apertural end and tapering posteriorly.

Discussion and Comparison: The Kaili specimen is similar to *S. willoughbyi* Conway Morris et Robison, 1988 from the Middle Cambrian of Utah (Conway Morris and Robison, 1988, p. 9–12, figs. 4–5) in the shape of the tube and gut. However, the but of the Kaili specimen is relatively larger in its anterior part.

图 版 说 明

图版照片标本除个别外,均产于台江八郎苗板坡剖面凯里组中上部凯里生物群所产层位,标本存放于贵州工业大学资源工程系地古实验室。编号前者为采集号(GTB 代表八郎乌溜剖面,GTBM 代表其北侧的苗板坡剖面),GK 为登记号。

图 版 I

- 1—3. *Palaeoscolex ratcliffei* Robison, 1969
- 1. 比较完整的躯干, 呈旋环状, 可见虫体环节及黑色消化道, $\times 3$; GTBM-8-5-682a, GK3415a;
 - 2. 为 1 的局部放大, 体环上可见小坑及乳突, 组成网状装饰, $\times 1.5$; GTBM-8-5-682a, GK3415a;
 - 3. 为 1 的局部放大, 可见乳突、小坑及黑色消化道, $\times 10$; GTBM-8-5-682a, GK3415a。
4. *Ottoia* sp.
- 两块标本虫体缓凸, 可见清楚的环节及环脊, $\times 2$; GTBM-8-5-1239a, GK3416。
5. *Selkirkia* sp.
- 躯干, 可见消化道系统(gut), $\times 4$; GTB-16-5-174a, GK3417。产于八郎乌溜剖面。
6. *Maotianshaniania* sp.
- 亚扁平状虫体, 可见躯体环节及环纹, $\times 6$; GTBM-21-588, GK3418。

图 版 II

- 1—3. *Cricocosmia*? sp.
- 1. 虫体躯体可见环节, 两侧环凸及黑色消化系统, $\times 3$; GTBM-9-1-489a, GK3419;
 - 2. 为 1 的局部放大, 可见两侧环节, 环凸, $\times 16$; GTBM-9-1-489a, GK3419;
 - 3. 躯干局部放大, 可见两侧黑色环凸及其间的消化腔, $\times 20$; GTBM-8-5-682a, GK3415。产于八郎乌溜剖面。
4. *Palaeoscolex ratcliffei* Robison, 1969
- 虫体部分躯干, 为 GTBM-8-5-682a 的副模, 可见环节, $\times 3$; GK3415b。
5. *Selkirkia* sp.
- 躯干, $\times 4$; GTB-16-5-174b, GK3417b。产于八郎乌溜剖面。
- 6, 7. *Ottoia* sp.
- 6. 两虫体互相扭在一起, $\times 3$; GTBM-8-9-1329, GK3416;
 - 7. 为 6 的躯体局部放大, 可见环脊由两排凸脊组成, 之间有缝; 环节上有细的横纹, 有时呈波状, 组成网状装饰, $\times 5$; GTBM-8-9-1329, GK3416。



