

# 吉林浑江地区早奥陶世亮甲山组的大型短粗壳内角石类<sup>\*</sup>

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**提要** 对产自吉林浑江大阳岔早奥陶世亮甲山组的大型粗壳内角石类进行系统研究, 共描述 2 科 3 属 7 种和 1 个科属未定标本, 其中 1 新属、3 新种和 2 未定种。首次报道 *Piloceratidae* 科分子 (*Paracassinoceras dayangchaense* gen. et sp. nov.) 在东亚的首次发现。提出内角石类内体管构造的 4 个类型。详细讨论 *Manchuroceras* 和 *Manchurceratidae* 科的地理分布。通过比较, 进一步论证早奥陶世鹦鹉螺动物两个地理区的存在, 即以 *Manchuroceras* 为代表的西太平洋地理区和以 *Piloceratidae* 为代表的大西洋地理区。

**关键词** 内角石类 头足类 早奥陶世 吉林

吉林南部早奥陶世地层和化石, 除下部冶里组在奥陶系/寒武系界线层型研究进程中曾经过深入研究外 (赵祥麟等, 1985; 段吉业等, 1986; Chen, 1986), 冶里组之上的地层和化石尚未开展系统的研究工作 (陈均远等, 1985)。其中所含头足类化石, 仅梁仲发 (1981) 描述了 6 属 7 种, 而区内集安县治安村附近 (插图 1) 奥陶系的研究还是个空白。有鉴于此, 笔者于 1986 年至 1988 年曾先后 3 次对本区奥陶系进行了详细的野外研究, 采得大量头足类化石标本。其中的珠角石类化石已经描述 (朱茂炎、李学森, 1996)。本文将讨论其中的内角石类。除集安县治安村亮甲山组目前尚未发现化石外, 区内上马家沟组和浑江流域的亮甲山组内均发现大量内角石类化石, 其中包括数量丰富的细长体管内角石类。本文仅选择浑江流域亮甲山组中的大型短粗壳内角石类进行描述, 共包括 2 科 3 属 7 种和 1 个科属未定标本, 其中 1 新属、3 新种和 2 未定种。

参加野外工作的有长春地质学院 87 届和 88 届毕业生郑利勋、张小峰、王军、何午等 4 同学。万雅琴、何宏伟协助磨片, 胡尚卿帮助照像, 笔者在此一并感谢。

## 1 内角石类化石保存特点和研究方法

浑江地区亮甲山组是一套形成于台地外边缘高能浅滩环境下的碳酸盐岩, 主要由白云岩组成。由于内角石体管内充填着厚重的原始钙质内锥 (endocones) 沉积, 而气室内无原始沉积物, 隔壁薄, 因此在高能海水中受波浪冲击振荡, 生物死后的外壳和隔壁常遭到破碎以至消失, 保存下来的主要是体管部分。因体管位于腹部, 紧贴腹部的壳壁和隔壁偶会有部分残存下来 (图版 I, 图 2)。

绝大部分体管在埋藏进程中, 内锥的原始钙质 (可能为文石) 经成岩硅化和方解石重结晶作用的破坏, 内锥及内隔壁 (endosiphosheathes) 很少能完整保存下来。而内体房壁、内锥管 (endosiphotube) 和体隙 (endosiphoblades) 等构造可能因结构致密、有机质含量较高的缘故常可完好保存。

至于这类体管标本的研究方法, 应根据两侧对称的构造特点, 首先观察并记录体管横断面轮廓, 再切制通过内锥管的背腹向纵切面, 然后再进行描述和分类。

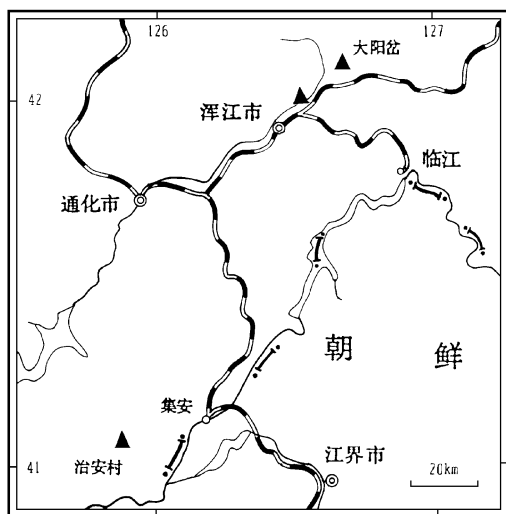


插图 1 化石产地交通位置图  
Sketch map shows fossil localities  
(black triangles)

## 2 满洲角石科 *Manchuroceratidae* 及其古地理分布

*Manchuroceratidae* 以 *Manchuroceras* 为特征分子, 曾一度繁盛于早奥陶世, 是大中型短粗壳内角石动物类群。其共有的特征为: 大中型直壳或弱内腹式弯曲壳, 放大较快。体管位于腹边缘, 横断面次圆形或椭圆形, 多呈背腹扁缩 (depressed), 常具有腹突 (ventral elevation) 和顶突 (apical projection)。化石一般仅保存为体管。它包含有 *Manchuroceras* Ozaki, 1927, *Parapiloceras* Obata, 1939, *Kerkoceras* Chen et Liu, 1974 等属。

*Manchuroceras* 一属自建立以来 (Ozaki, 1927), Kobayashi (1935, 1977) 先后对该属的属征进行了详细的讨论和修订。典型的 *Manchuroceras* 广泛分布于华北地台东部地区的山东、河北、辽宁、吉林等地, 前人共描述了 10 种。根据壳形、体管横断面轮廓、腹突发育状态和内体房等特征, 可将华北地台东部所产的 *Manchuroceras* 大致分为 2 种类型:

1) 体管横断面椭圆形, 背腹扁缩, 腹部扁平具明显腹突。体管表面有代表缝合线的、向腹部上升的明显环纹。内体房顶角小, 一般小于  $45^\circ$ , 叠锥厚, 内锥管明显。包括 *Manchuroceras platyventrum* (Grabau, 1922), *M. wulonenses* (Kobayashi, 1931), *M. compressum* (Kobayashi, 1931), *M. endoi* (Kobayashi, 1935), *M. ozaki* (Obata, 1939), *M. kobayashii* (Obata, 1939), *M. circuliforme* sp. nov.

等。

2) 体管横断面次圆形, 腹部圆缓, 腹突不明显。表面环纹较平直。内体房顶角大, 一般均大于  $90^\circ$ 。叠锥相对较薄, 内锥管不发育。包括: *M. manchuriense* (Endo, 1932), *M. yenchouchenhense* (Obata, 1939), *M. katsunumai* (Obata, 1939) 等。

至于 *M. ishidai* (Obata, 1939) 一种, 为外腹式弯曲的体管, 与上述两类 *Manchuroceras* 区别明显, 如果 Obata (1939) 描述无误, 则不应归入 *Manchuroceras* 属内。

在华北地台西北部的内蒙古清水河和山西偏关地区, 陈均远 (1976) 和邹西平 (1981) 曾先后描述了 *Manchuroceras qinshuihense*, *M. yazipingense*, *M. pianquanense*, *M. minutuai* 4 种。后 3 种为小型短粗的体管化石, 始端快速放大后体管变为近圆柱形, 并在成年期有微弱收缩。横断面扁圆形, 腹部较平但腹突不明显。通常只有典型 *Manchuroceras* 壳体的  $1/4$  大小, 可能代表 *Manchuroceras* 另一个类群。

张日东 (1965) 曾描述产自青海祁连山地区下奥陶统的 *M. todushanense*, 曾被 Flower (1977) 否定。但从图版所示的特征来看, 该种应属典型 *Manchuroceras* 无疑。在西藏南部, 陈均远 (1975) 和陈挺恩 (1983, 1984) 也曾先后报道有 *Manchuroceras* 的分布。

在华南扬子区内下奥陶统红花园组, 张鸣韶、盛莘夫 (1958) 曾报道有 *M. cf. wulongense*, 但未示图片。陈均远、刘耕武 (1974) 描述的 *M. badongense*, 壳体小, 始端快速放大后变为圆柱形, 横断面圆形, 体管内锥在腹部强拱, 内体房横断面月牙形, 与 *M. longitubulum* sp. nov. 相似, 但前者个体小, 腹部圆钝, 圆柱状, 与典型的 *Manchuroceras* 有明显区别。

毗邻我国东北的朝鲜半岛也有大量 *Manchuroceras* 的发现。Kobayashi (1977) 曾描述产自韩国的 *Manchuroceras* 4 种和 1 未定种。其中 *M. tenuise* 体管细长, 与短粗的 *Manchuroceras* 有明显区别, 尽管其腹部腹突明显并有一体隙穿进, 但体隙在 *Manchuroceras* 属内并非主要特征。

Teichert (1947) 曾描述产自大洋洲塔斯马尼亚下奥陶统灰岩中的 *M. steanei* 和 *M. exaratum* 二种, 它们与北美的 *M. lemonei* (Flower, 1977) 相似。正如 Flower (1977) 指出的, 它们是一类小型短粗状体管化石, 与华北地台东部和朝鲜半岛的 *Manchuroceras* 明显不同, 即具有更加短粗的体管

外形,浅的内体房,顶端有明显的乳状突起,侧向放大快,横断面近圆形。

Manchuroceratidae 科中的 *Parapiloceras* 仅见于我国的华北地台东部(Obata, 1939; 梁仲发, 1981; 本文等)。*Kerkoceras* 在华北和扬子区均有发现(陈均远、刘耕武, 1974; 陈均远, 1976)。

由上述讨论可见,除 *Kerkoceras* 外,Manchuroceratidae 的典型属 *Manchuroceras*, *Parapiloceras* 主要分布在我国华北地台东部和朝鲜半岛,向西可延伸至祁连山区和西藏南部。因此,在早奥陶世明显存在着以 *Manchuroceras* 为代表的繁盛于西太平洋和以 *Piloceratidae* 为代表的繁盛于大西洋周边的两个头足类生物地理区(Kobayashi, 1977)。

### 3 枕角石科 Piloceratidae 分子在我国的首次发现及其古地理学意义

主要分布在大西洋周边地区的 *Piloceratidae* 科分子以两侧扁缩(compressed)的弯曲弓形壳为特征,与以 *Manchuroceras* 为代表的 Manchuroceratidae 科具有明显的差异。尽管非典型的小型 *Manchuroceras* 在北美也有发现(Flower, 1977),但西太平洋地理区与大西洋地理区内的典型分子互不共生。笔者在吉林南部发现的 *Paracassinoceras dayangchaense* gen. et sp. nov. (图版Ⅲ, 图 3, 6, 7) 是 *Piloceratidae* 分子在我国及西太平洋地区的首次发现。*Paracassinoceras* 也具有典型的两侧扁缩的弓形壳特征,但体管更加短粗,放大极快,内体房顶角大,内锥薄,与大西洋地理区的 *Piloceratidae* 分子有较明显差别。进一步说明两地理区内特征分子互不共生的现象。大型内角石类的这种地理分布,证实了早奥陶世两地理区之间存在地理障碍与隔离。这类动物适应于浅水生活,营游移底栖生活方式,游泳能力差,地理隔离限制了其分布的广泛性。早奥陶世地理隔离还促使内角石类在各自地理区内不同的演化趋向。*Piloceratidae* 是承袭晚寒武世 *Ellesmeroceratida* 目的两侧扁缩的特征延续发展,而 *Manchuroceratidae* 则向着背腹扁缩的方向发展。

### 4 内角石类的内体管构造

内角石类的内体管(endosiphuncle)由内锥构成。关于内体管和内锥的构造特征,曾先后有

Kobayashi (1935, 1947)、Teichert (1964, 1974)、Collins (1967) 等学者做过详细的研究。Collins (1967) 将内体管分为两种类型,即简单型和复杂型。简单型内体管中的内锥管有简单的横隔膜(diaphragms),他认为这种横隔膜与内隔壁无关;复杂型内体管中内锥管有复杂的横隔膜,它与内隔壁相连。Teichert 1974 年用穿孔的(perforate, pierced)内锥和不穿孔的(imperforate, unpierced)内锥两种类型来取代 Collins (1967) 的简单型和复杂型。

内锥和内体管构造的研究取决于化石保存的好坏程度。在研究吉林南部下奥陶统中的内角石类化石过程中,笔者发现许多标本保存甚佳的内锥及横隔膜构造(图版 I, 图 1, 3, 8; 图版 II, 图 3, 7, 9; 图版 III, 图 4)。标本显示所谓的横隔膜实系内隔壁在内锥管中的延伸部分。

经笔者仔细审查前人相关标本的图版,认为过去所谓简单型穿孔的内锥是不存在的。已描述的 *Manchuroceras wolongense* (Kobayashi, 1935), *Penhsioceras* (?) sp. (Kobayashi, 1947), “*Ecdyceras*” (Flower, 1962), *Bisonoceras*, *Dartonoceras* 和一未定名标本(Flower, 1964, pl. 4, figs. 10, 12) 以及 *Loxendoceras frimerum* (Collins, 1967), *Cameroceras* sp. cf. *C. manitobense* (Teichert, 1974) 等内体管构造保存较好的标本均显示出横隔膜与内隔壁相联的特征。至于有些标本如 *Lobendoceras* (Collins, 1967, pl. 141, figs. 1—3) 横隔膜似与内锥和内隔壁无关,可能是因为遭重结晶改造的缘故。

笔者认为随着动物体的生长,内体管中的内锥增生方式可能有如下几种类型:1) 内体房顶角较小,生长过程中顶角不变,内锥呈等距增生(插图 2a),常见于细长体管的内角石类;2) 内体房深,顶端圆钝,内锥等距增生,在顶端内锥之间留有空隙(Teichert, 1974, pl. 2, fig. 2; text fig. 3) (见插图 2b);3) 内体房顶角由小逐渐增大,内锥叠加紧密成组,每一内锥组顶之间有空隙(插图 2c; 图版 III, 图 4);4) 内体房顶角随着生长过程周期性由大变,并逐渐发展成一顶凹(插图 2d; 图版 I, 图 1, 3, 8),这在 *Manchuroceras* 属的体管内常见。

内锥的增生方式和内体房顶端的变化是与动物软体生长过程中的变化紧密相关的。内锥体代表着动物体的快速增长阶段,而内隔壁则可能代表着动物生长短暂的停止阶段。因此,研究内锥的增生方式对内角石类动物的发育和生态的了解有着重要意义。

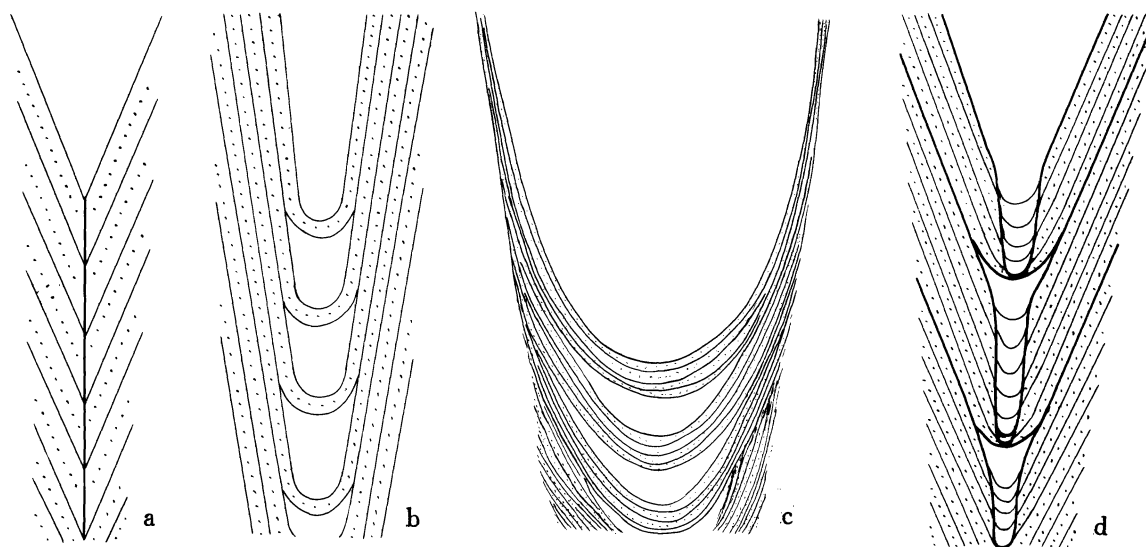


插图 2 内角石类内体管构造示意图

Sketch drawings show endosiphuncular structures of endoceroids. a·sharp apical angle of endosiphuncone, endocone and its apical angle keep uniform during growth. It is common in the endoceroids with slender siphuncles. b·deep endosiphuncone with broad apical angle, endocone and its apical angle keep uniform during growth. But there is a gap between the apical ends of endocones. c·the apical angle of endosiphuncone periodically changes from low to large during the growth. d·the apical angle of endosiphuncone periodically changes from large to low during the growth, and gradually develops a funnel shape.

(图版Ⅲ, 图 3, 6, 7)

## 5 系统描述

**内角石目 Order Endoceratida Flower, 1950**

**枕角石科 Family Piloceratidae Miller, 1889**

**副卡辛角石属(新属) *Paracassinoceras* gen. nov.**

**模式种 *Paracassinoceras dayangchaense* gen. et sp. nov.**

**属征** 壳大, 体管粗大, 扩大迅速, 短粗锥状, 微弱内腹式弯曲, 腹部较平直。表面具微弱环纹, 横断面呈直立椭圆形, 两侧扁缩。内体房(endosiphuncone)宽浅, 顶角大, 叠锥部分薄。体管口缘两侧后凹, 腹部和背部各向前突出。

**讨论** 新属与 *Piloceras*、*Allopiloceras* 和 *Cassinoceras* 3 属在体管短粗锥状、两侧扁缩等方面均很相似, 但新属以体管较大、更加短粗、放大更快、内体房更宽浅以及叠锥体薄等特点而区别于后 3 属; 并以体管较直而区别于 *Piloceras*。新属以体管较直、短粗锥状和横切面两侧扁缩等特征而区别于 *Parapiloceras* 的弯曲状体管和圆形横断面。该新属是 *Piloceratidae* 分子在华北的首次发现。

**分布时代** 中国北部; 早奥陶世。

**大阳岔副卡辛角石(新属、新种) *Paracassinoceras dayangchaense* gen. et sp. nov.**

**描述** 标本有 3 块, 正模标本为体管部分, 长 83 mm。体管较大, 短粗锥状, 微弱内腹式弯曲, 腹部较平直, 背部微突。腹背向扩大率为 1:1.6, 表面有微弱环纹。横断面呈直立卵圆形, 两侧扁缩, 腹端较背端为窄, 腹部较厚。内体房宽浅, 呈宽锥状, 顶角大, 约 60°, 从体管的腹背向纵切面观之, 其腹、背和体管顶三点可大致构成一等边三角形。体管叠锥部分薄。体管口缘两侧后凹, 腹部和背部各向前突出。此口缘轮廓也大致反映其气壳(phragmocone, 闭锥)隔壁内缘向后弯曲之形态。

**产地层位** 吉林浑江大阳岔; 下奥陶统亮甲山组中部。

**满洲角石科 Family Manchuroceratidae Kobayashi, 1935**

**满洲角石属 Genus *Manchuroceras* Ozaki, 1927**

**圆形满洲角石(新种) *Manchuroceras circuliforme* sp. nov.**

(图版 I, 图 1—3, 7, 8)

**描述** 标本有两块, 皆保存为体管部分, 其中正模标本体管直, 全长 90 mm, 成年期扩大率为 1:3。表面具向腹部上升的横环, 20 mm 长度内有 5 个横环。横断面圆形, 从体管腹面残留有外壳碎片这一特征可以表明体管位于腹边缘, 腹突明显。内体房

较深,顶角 $41^{\circ}$ 。内锥管长,最宽处 $1.2\text{ mm}$ ,内具不规则的横隔膜。

副模标本体管长 $77\text{ mm}$ ,体管顶端具一乳状突起,幼年期扩大率为 $1:4$ ,成年期扩大率为 $1:3.6$ ,横断面圆形,腹突明显。内体房较深,顶角 $43^{\circ}$ ,内锥管较长,内具密集而规则的横隔膜。

**比较** 新种以体管横断面圆形和内体房顶角大为特征区别于属内大多数种。*Manchuroceras platyventrum* (Grabau)、*M. manchuriense* (Endo) 和 *M. yenchouchengense* Obata<sup>3</sup> 种横断面虽也呈圆形,但其体管成年期扩大率都很小,内体房顶角也很小。新种与 *M. wulongense* (Kobayashi) 相比,后者体管扩大率明显较小,表面横环较细,腹突高大,内体房顶角也较小。

**产地层位** 吉林浑江大阳岔;下奥陶统亮甲山组中部。

### 长管满洲角石(新种) *Manchuroceras longitubulum* sp. nov.

(图版 II, 图 3—5, 7)

**描述** 标本为体管部分,长 $90\text{ mm}$ ,从腹部尚保留部分外壳来判断,显示其体管位腹边缘。体管幼年期扩大迅速,成年扩大缓慢,腹部平直,体管表面具粗壮横环,微向腹部上升,在 $20\text{ mm}$ 长度内可有5个横环。横断面为扁平椭圆形,背腹扁缩,腹突明显。内锥发育,腹侧和背侧各具一体隙,内体房背腹直径极狭窄,而侧向直径横宽,横断面观之,背腹两体隙与狭窄的内体房两端相连,形成“S”构造。内体房窄浅,顶角小于 $20^{\circ}$ ,内锥管细长达 $60\text{ mm}$ ,其中具不规则的横隔膜。

**比较** 该新种以横断面、内体房与腹背两体隙相连形成“S”构造、窄浅内体房、深长叠锥体以及细长内锥管等为特征而与属内其它各种相区别。

**产地层位** 吉林浑江大阳岔;下奥陶统亮甲山组中部。

### 扁形满洲角石 *Manchuroceras compressum* (Kobayashi) emend. Obata, 1939

(图版 I, 图 4—6)

1931 *Piloceras* var. *compressa*, Kobayashi, p. 173, pl. 18, fig. 3.

**描述** 标本保存为体管部分,全长 $105\text{ mm}$ 。体管微弱内腹式弯曲,背腹扩大率很小,两侧扩大率大为 $1:3.5$ 。体管表面具有向腹部上斜的宽平横环, $20\text{ mm}$ 距离内具4个横环。横断面背腹扁缩明显,近半

圆形,腹突明显。内体房深,顶角小,内锥管较长。

**比较** 当前标本与正模标本 *M. compressum* (Kobayashi), 1931 极为相似,体管横断面均为明显腹背扁缩,但后者弯曲度小,且放大较缓慢。

**产地层位** 吉林浑江大阳岔;下奥陶统亮甲山组。

### 满洲角石(未定种 A) *Manchuroceras* sp. A

(图版 III, 图 1, 2, 4)

**描述** 当前标本全长 $100\text{ mm}$ ,为粗大体管部分,近直锥形,微弱内腹式弯曲,始端扩大迅速,后变缓慢,体管表面环纹不清,壮年期横断面近圆形,成年期横断面扁圆形,背腹扁缩,两侧直径长 $65\text{ mm}$ ,背腹直径 $48\text{ mm}$ 。腹部稍平,腹突不明显,可见有4条体隙,分布不规则。内体房始端顶角大,圆钝,后期夹角变小。叠锥部分较厚,为 $30\text{ mm}$ ,约占体管长度的 $1/3$ 强。

**讨论** 该未定种以内体房顶角大而圆钝和内锥管前端内锥发育为横隔膜的中间类型为特征,该结构特征为内锥发育为横隔膜的有力证据。此内锥结构较为少见,有待更多的标本进行详细分类。虽仅1块标本,但在内锥与横隔膜关系的研究上具有一定意义。

**产地层位** 吉林浑江大阳岔;下奥陶统亮甲山组。

### 满洲角石(未定种 B) *Manchuroceras* sp. B

(图版 II, 图 1, 2)

**描述** 大型壳,标本保存为粗大体管部分,全长 $120\text{ mm}$ ,幼年期扩大迅速,壮年期变缓慢,但成年期扩大又变快,从顶端向前 $45\text{ mm}$ 处测得其侧向扩大率为 $1:3.5$ 。并向体管两侧放开,从整个体管侧向纵切面观之,呈倒钟形。成年期横断面为明显背腹扁缩,具腹突。体管呈微弱内腹式弯曲。表面纹饰不明显。体管口端侧向直径 $70\text{ mm}$ ,背腹直径 $57\text{ mm}$ 。内体锥顶端顶角 $90^{\circ}$ 。前端顶角 $35^{\circ}$ 。内体房深长 $86\text{ mm}$ 。横断面可见有3个体隙,分布不规则。叠锥体厚 $30\text{ mm}$ ,约占全体管长度 $1/4$ 。

**比较** 该未定种特征是体管幼年期扩大快,壮年期近平行,成年期又向两侧扩大较快,使整个体管切面呈倒钟形。内体房深长,内锥具有3个分布不规则的体隙。可区别于属内各种。由于仅1块标本,特征是否稳定,有待更多标本论证,故暂不定新种。

**产地层位** 吉林浑江大阳岔,下奥陶统亮甲山组。

### 副枕角石属 Genus *Parapiloceras* Obata, 1939

## 大型副枕角石 *Parapiloceras magnum* Liang, 1981

(图版 II, 图 6, 8, 9)

1981 *Parapiloceras magnum*, 梁仲发, 394 页, 图版 I, 图 1。

**描述** 目前标本为体管部分, 全长 135 mm, 体管粗大, 内腹式弯曲, 扩大迅速, 标本始部直径 18 mm, 向前 50 mm 起其直径扩大到 53 mm, 顶角 45°, 体管表面环纹不明显。横断面圆形, 具腹突构造, 内体房深, 超过 58 mm, 内锥管发育。

**比较** 目前标本与正模标本特征基本一致, 但后者体管成年期扩大较迅速, 弯曲度也较大。

**产地层位** 吉林浑江大阳岔; 下奥陶统亮甲山组中上部。

## 科属未定 Family et Genus indet.

(图版 III, 图 5, 8)

**描述** 标本保存为体管部分, 全长 40 mm, 短粗型, 扩大迅速, 腹背直径 30 mm, 两侧直径 42 mm, 体管表面光滑。横断面椭圆形, 背腹扁缩, 两侧加厚, 而腹背较薄, 致使内体房横断面近圆形。内体房宽浅, 顶角大约 110°, 叠锥部分较发育, 厚 21 mm, 约占体管全长 1/2。

**讨论** 标本的突出特点是, 初看之体管的椭圆形横断面两端有加厚现象, 似为两侧扁缩, 而应归入枕角石科; 但若从背、腹相对位置和对称性分析, 标本显然是背腹扁缩而应归类满洲角石科, 但又缺乏满洲角石科所具备的腹部加厚和特有的腹突等特征。目前标本不仅缺少腹部加厚和腹突, 相反, 与众不同的是体管背腹扁缩而两侧加厚。此特征与内角石目内各科均不一致。因标本仅 1 块, 特征是否稳定, 尚需要更多材料证实, 暂不定名归类。

**产地层位** 吉林浑江大阳岔; 下奥陶统亮甲山组。

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# LARGE BREVICONIC ENDOCEROIDS FROM THE EARLY ORDOVICIAN LIANGJIASHAN FORMATION OF HUNJIANG, SOUTH JILIN PROVINCE, PRC

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**Key words:** cephalopods, endoceroids, Ordovician, Liangjiashan Formation, Jilin

## Summary

Hunjiang area of South Jilin Province is well-known to geologists for its very famous Cambrian-Ordovician boundary section at Dayangcha (Chen, 1986), but the Ordovician cephalopods in this area have not been well studied, except for a few specimens described by Liang (1981). In 1986–1988, a large number of nautiloids (endoceroids, actinoceroids, orthoceroids, pseudorthoceroids and etc.) were collected from the Lower Ordovician of South Jilin Province by the present authors. The actinoceroids have been investigated (Zhu and Li, 1996), here we only describe the large breviconic endoceroids from the Liangjiashan Formation at Dayangcha (text-fig. 1), including 1 new genus, 3 new species and 1 family and genus indeterminate specimen.

All studied specimens show that only siphuncular parts of the phragmocones are preserved, suggesting that the Liangjiashan Formation represents the sediments under high-energy environments, and the shell wall and septa of these endoceroids are fragile without cameral deposits. Original composition and internal structures of the siphuncles were destroyed by silification and recrystallization, but usually the endosiphotubes are partly well preserved and the endosiphosheathes near the endosiphotubes are also clearly shown. One specimen shows well-preserved endosiphuncular structures (Pl. III, fig. 1). All studied specimens reveal that the diaphragms are the extended part of the endosiphosheathes in the endosiphotube. Based on the specimens from the Liangjiashan Formation and the specimens illustrated by Kobayashi (1935, 1947), Flower (1964), Collins (1967), and Teichert (1974), 4 types of the endosi-

phuncular structures are proposed (Text-fig. 2). The simple (perforate) endocones, which was illustrated by Collins (1967), is interpreted here as the result of diagenetic destruction. It is assumed that the different types of endosiphuncular structures are related to growth and metabolism of the animal.

After reviewing all *Manchuroceras* described previously from East Asia, it is clearly shown that there are two groups of *Manchuroceras*: 1) The siphuncle is dorsoventrally compressed with elliptical cross-section and obvious ventral elevation. Annulations on the surface bend ventrally and orally. Endosiphococone has a sharp apical angle, generally less than 45°. Endocone is thick, and endosiphotube is obvious. The species included in this group are *M. platyventrum* (Grabau, 1932), *M. wulongenses* (Kobayashi, 1931), *M. compressum* (Kobayashi, 1931), *M. endoi* (Kobayashi, 1935), *M. ozaki* (Obata, 1939), *M. kobayashii* (Obata, 1939) and *M. circuliforme* sp. nov.; 2) The siphuncle has a sub-circular cross-section without obvious ventral elevation. Annulations on the surface are straight. Endosiphococone has a large apical angle, generally large than 90°. Endocone is thin and endosiphotube usually is not clear. The species included in this group are *M. manchuriense* (endo, 1932), *M. yenchouchenhense* (Obata, 1939) and *M. katsunumai* (Obata, 1939). Interestingly, Chen (1976) and Zhou (1981) described 4 species of *Manchuroceras* from the western part of North China platform, among them *M. yazipingense*, *M. pianguanense* and *M. minutuai* have small breviconic siphuncles, usually the diameter is less than 1/4 of the characteristic *Manchuroceras*. Their cross-sections are subcircular without obvious ventral elevation. These species may represent another subgroup of *Manchuroceras*: *M. badongense* from

the Lower Ordovician Honghuayuan Formation of the Yangtse platform also shows significant differences from the characteristic *Manchuroceras* (Chen and Liu, 1974). It is worthy of notice that *M. toduan-shanense* from the Lower Ordovician in Mt. Qilian area in Qinghai Province (Zhang, 1965), which was regarded as misidentification by Flower (1977), represents actually a characteristic *Manchuroceras*. On the other hand, *M. ishidae* shows exogastric siphuncle (Obata, 1939) that is different from the endogastric siphuncle of *Manchuroceras*, therefore, it is considered here to be others. In comparison with *Manchuroceras* from Australia (Teichert, 1947) and North America (Flower, 1977), two cephalopod provinces (Manchuroceratidae and Piloceratidae provinces) during Early Ordovician can be distinguished. The Manchuroceratidae Province is located on the west pacific side, including the North China platform (Grabau, 1922; Kobayashi, 1931a, b, 1935, Obata, 1939; Endo, 1932; Chen, 1976; Zhou, 1981), south and north Korea (Kobayashi, 1977), Mt. Qilian area (Zhang, 1965) and south Tibet (Chen J. Y., 1975; Chen T.-E., 1983, 1984), whereas the Piloceratidae Province is on the Atlantic side (Kobayashi, 1977). Although *Manchuroceras* was also discovered in North America and Tasmania, they are obviously different from typical members of East Asia (Flower, 1977). A new genus *Paracassinoceras* described here, which possessed typical characters of Piloceratidae, is the first record of the members of Piloceratidae in East Asia. But *Paracassinoceras* gen. nov. also shows obvious differences from the members of Piloceratidae distributed in Atlantic Province. This provides more evidences for existence of the cephalopod provinces existed in Early Ordovician.

## DESCRIPTION

### Order Endoceratida Flower, 1950

### Family Piloceratidae Miller, 1889

### Genus *Paracassinoceras* gen. nov.

**Type species:** *Paracassinoceras dayangchaense* gen. et sp. nov.

**Diagnosis:** Large and slightly endogastrically curved brevicones with laterally compressed cross-section.

Siphuncle large, breviconic, rapidly expanded and slightly endogastrically curved with laterally compressed cross-section. Endocone thin and endosiphuncle broadly shallow with large apical angle.

**Remark:** The new genus differs from other members of Piloceratidae in its more breviconic phragmocone, thinner endocone and more broadly shallow endosiphuncle with large apical angle.

**Occurrence:** Early Ordovician, North China.

### *Paracassinoceras dayangchaense* gen. et sp. nov.

(Pl. III, figs. 3, 6, 7)

**Diagnosis:** The siphuncle large, breviconic and slightly endogastrically curved, expanding rate 1:1.6; cross-section compressed. Endocone thin, endosiphuncle broadly shallow with 60° apical angle. The ventral and dorsal adoral margin protruded anteriorly, and the lateral adoral margin curved posteriorly.

**Occurrence:** Liangjiashan Formation at Dayangcha, Hunjiang, South Jilin Province.

### *Manchuroceras circuliforme* sp. nov.

(Pl. I, figs. 1-3, 7, 8)

**Diagnosis:** The siphuncle large and straight with apical projection and annulations ascending from dorsum to venter, expanding rate in adult 1:3; cross-section circular. Endocone thicker in dorsum than in venter, with ventral elevation. Endosiphontube curved in young and nearly straight in adult with diaphragms extending to endocones. Endosiphuncle relatively deep with 41° apical angle.

**Occurrence:** Liangjiashan Formation at Dayangcha, Hunjiang, South Jilin Province.

### *Manchuroceras longitubulum* sp. nov.

(Pl. II, figs. 3-5, 7)

**Diagnosis:** The siphuncle large and straight with annulations ascending from dorsum to venter, expanding rapidly in apical part and slowly in adult; cross-section subelliptical and strongly depressed with flat ventral side. Endocone long, thicker in dorsum than in venter, with ventral elevation. Endosiphontube extremely long, curved in young and straight in adult with diaphragms extending to endocones. Endosiphuncle depressed laterally and deep, connecting with two endosiphoblades to form "s"-like outline in



cross section.

**Occurrence:** Liangjiashan Formation at Dayangcha, Hunjiang, South Jilin Province.

### *Manchuroceras* sp. A

(Pl. III, figs. 1, 2, 4)

**Description:** Only a 100 mm long siphuncle was preserved. The siphuncle large and straight, expanding rapidly in apical part and slowly in adult; cross-section circular to subcircular anteriorly. Endocones in adult closely repeat progressively and repeatedly form a space between different groups of endocones in apical part, with 4 irregular endosiphoblades and without ventral elevation. Endosiphococone deep with obtuse apical angle.

**Comparison:** This specimen differs from other species of *Manchuroceras* in its obtuse apical part of endosiphococone and characteristic endocones in adult.

**Occurrence:** Liangjiashan Formation at Dayangcha, Hunjiang, South Jilin Province.

### *Manchuroceras* sp. B

(Pl. II, figs. 1, 2)

**Description:** Only a 120 mm long siphuncle was preserved. The siphuncle large and slightly endogastrially curved, expanding rapidly in apical part, slowly from 30 mm to 45 mm and rapidly again in adult; cross-section subelliptical. The thickness of endocone moderate, ventral elevation not obvious. Endosiphococone deep and invert bell-shaped with obtuse apical angle.

**Comparison:** This specimen differs from other species of *Manchuroceras* in its invert bell-shaped endosiphococone.

**Occurrence:** Liangjiashan Formation at Dayangcha, Hunjiang, South Jilin Province.

### Family and Genus indeterminate

(Pl. III, figs. 5, 8)

**Description:** Only siphuncle was preserved with 40 mm length. The siphuncle moderate and breviconic, expanding rapidly; cross-section subelliptical with 30 mm dorsoventral diameter and 42 mm lateral diameter, strongly depressed. Endocone thickened laterally. Endosiphococone shallow with 110° apical angle.

**Comparison:** This specimen differs from mem-

bers of *Piloceratidae* in its depressed siphuncle and differs from members of *Manchuroceratidae* in its lateral thickened endocone.

**Occurrence:** Liangjiashan Formation at Dayangcha, Hunjiang, South Jilin Province.

### 图版说明 (Explanation of Plates)

所有标本均采自吉林浑江大阳岔下奥陶统亮甲山组。标本未加任何润饰,存放于中国科学院南京地质古生物研究所标本库,采用库内的统一登记号。除注明放大倍数外,余均原大。横断面照片均属腹部朝下,背部朝上(All specimens illustrated here were collected from the Liangjiashan Formation of Early Ordovician of south Jilin Province, and deposited in Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Except the marked magnification, all other photos represent original size. The cross-sections are illustrated with orientation of ventral side down and dorsal side up)。

#### 图版 I

1—3, 7, 8. *Manchuroceras circuliforme* sp. nov.

1. 背腹向纵切面(dorsal-ventral longitudinal section); 2. 横切面(cross-section); 正模(holotype), 登记号: 124570。3. 内椎管局部放大(enlargement of endosiphotube), ×4, 登记号: 124570; 8. 背腹向纵切面(dorsal-ventral longitudinal section); 7. 横切面(cross-section); 副模(paratype), 登记号: 124571。

4—6. *Manchuroceras compressum* (Kobayashi) emend. Obata, 1939

4. 口视(oral view); 5. 腹视(ventral view); 6. 侧视(lateral view); 登记号: 124569。

#### 图版 II

1, 2. *Manchuroceras* sp. B

1. 横切面(cross-section); 登记号: 124573; 2. 背腹向纵切面(dorsal-ventral longitudinal section)。

3—5, 7. *Manchuroceras longitubulum* sp. nov.

3, 7. 背腹向纵切面(dorsal-ventral longitudinal section); 4. 横切面(cross-section), 顶视(apical view); 5. 横切面(cross-section), 口视(oral view); 正模(holotype), 登记号: 124572。

6, 8, 9. *Parapiloceras magnum* Liang, 1981

6. 横切面(cross-section); 8, 9. 背腹向纵切面(dorsal-ventral longitudinal section); 登记号: 124575。

#### 图版 III

1, 2, 4. *Manchuroceras* sp. A

1. 横切面(cross-section), 顶视(apical view); 2. 自然横断面(natural cross-section), 口视(oral view); 4. 背腹向纵切面(dorsal-ventral longitudinal section); 登记号: 124574。

3, 6, 7. *Paracassinoceras dayangchaense* gen. et sp. nov.

3. 背腹向纵切面(dorsal-ventral longitudinal section), 副模(holotype), 登记号: 124577; 6. 横切面(cross-section), 口视(oral view); 登记号: 124576; 7. 背腹向纵切面(dorsal-ventral longitudinal section), 正模(holotype), 登记号: 124576。

5, 8. Family et Genus indet.

5. 背腹向纵切面(dorsal-ventral longitudinal section), ×1.5; 8. 横切面(cross-section), ×2.5, 登记号: 124578。