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葫芦虫化石在寒武纪关山生物群中的发现及其意义*

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提要 报道产自昆明高楼房的寒武纪早期关山生物群中的葫芦虫化石,这是该类动物在全球的第三例化石记录。葫芦虫化石在关山生物群的发现对了解该类动物以及寒武纪动物群生态和演化等均有着重要意义。

关键词 葫芦虫 关山生物群 寒武纪早期 云南

1 前 言

葫芦虫是一类奇特的动物类型,形似葫芦,具有类似曳鳃动物(也译成"鳃曳动物")的翻吻,躯干表面具有特殊的兜甲构造。葫芦虫类最早报道于寒武系第二统第三阶的澄江生物群(侯先光等,1999;陈良忠等,2002;Luo *et al.*,1999;Hou *et al.*,2017)。澄江生物群中葫芦虫化石极为丰富,目前已经收集到的标本约有 1 000 多块,包括两个属:葫芦虫 *Sicyophorus*(=始鳃曳虫 *Protopriapulites*)(侯先光等,1999;Luo *et al.*,1999)和古鳃曳虫 *Palaeopriapulites*。两者具有较为相似的外形,主要区别在于 *Sicyophorus* 躯干表面具兜甲状外皮,肠道粗大,呈盘旋状;而 *Palaeopriapulites* 躯干表面具刺且肠道细而直。除澄江生物群外,寒武系第三统第五阶的凯里生物群也有发现(赵元龙等,2011),但凯里生物群的葫芦虫类目前尚未详细研究。根据其躯体造型及与实体化石保存在一起的遗迹,葫芦虫被认为是营潜穴生活(Lei *et al.*,2014)。

由于葫芦虫类具有独特的躯体构型,其分类位置及亲缘关系一直存在争议。从外形看,葫芦虫类具有类似于兜甲动物的纵列隔板,其卷曲盘绕的肠道区别于所有其他环神经类动物。葫芦虫类有类似曳鳃动物的翻吻和可能的尾突,但其躯干无环纹、肠道卷曲盘绕等特征区别于任何已经灭绝或现生的曳鳃动物类型。罗惠麟等(1999)最早将其置于分类位置未定的化石类型;侯先光等(1999)将该类化石归入曳鳃动物,认为与现生曳鳃动物的幼虫非常相似;其后多个学者将其归入曳鳃动物基干类群(Wills,1998;Dong *et al.*,2010;Wills *et al.*,2012);另外一些学者则认为葫芦虫类系兜甲动物(loriciferan)(Huang,2005;Mass *et al.*,2007;Ma *et al.*,2010)。根据分支分析的结果,Harvey 等(2010)认为葫芦虫类位于曳鳃动物干群的最基部。最近的研究也认为葫芦虫类属于曳鳃动物基干类群或者有棘类基干类群(Ma *et al.*,2014;Hou *et al.*,2017)。

到目前为止,有关葫芦虫的研究绝大部分都是依托澄江生物群的材料。最近我们在昆明附近的高楼房关山生物群化石产地发现了葫芦虫化石,为研究这类动物提供了新的材料和信息。

关山生物群是产于云南东部寒武系第二统乌龙箐组的一个特异埋藏的软躯体后生动物化石群,其时代介于澄江生物群与凯里生物群之间,是一个典型的布尔吉斯页岩型生物群(朱茂炎,2010)。含软躯体化石的层位跨越 *Palaeolenus* 和 *Megapalaeolenus* 两个三叶虫生物带,属于寒武系第二统第四阶。目前已经发现的化石类型有节肢动物(包括三叶虫类、金臂虫类、吐卓虫类和等刺虫类等)、古虫类、古蠕虫类、多毛类、腕足类、叶足类、水母状化石、

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开腔骨类、奇虾类及海绵动物和宏观藻类等(罗惠麟等,1999,2008;胡世学等,2013;Hu *et al.*,2010)。本文描述的葫芦虫化石仅见于乌龙箐组下部的 *Palaeolenus* 带底部黄绿色泥岩之中,共生的三叶虫化石有 *Palaeolenus lantenoisi* 和 *Redlichia mansuyi*。葫芦虫是关山生物群最为稀少的化石类型之一,目前为止仅发现一块标本。化石保存完好,具正负模,呈棕红色,与黄色围岩有明显区别。翻吻、躯干清晰可见,肠道呈三维立体状保存,最为明显。

本文研究材料采集地点 GPS 位置为 24°57′20″E,102°48′20″N,系在野外顺层面劈开泥岩获得。化石用佳能 Mark Ⅱ 相机配备 EF 100 mm f/2.8 L IS USM 微距镜头在阳光下拍摄,局部细节放大在 ZEISS Smartzoom 5 显微镜下完成。图片处理及图版编排利用 Adobe Photoshop CS3 完成。

2　系统古生物学

纲、目未定　Class and Order uncertain

葫芦虫科　Sicyophoridae Luo and Hu in Chen *et al.*,2002

葫芦虫属　*Sicyophorus* Luo and Hu,1999 in Luo *et al.*,1999

模式种　*Sicyophorus rara* Luo and Hu *in* Luo *et al.*,1999

产地层位　云南东部,寒武系第二统第三至第四阶。

葫芦虫属未定种　*Sicyophorus* sp.

(插图 1)

材料　仅一枚标本(NIGPAS167700),由本文作者之一的董存治发现。化石保存完好,具正负模(插图 1a,1b)。标本保存在中国科学院南京地质古生物研究所。

描述　虫体小,长 10.9 mm,由翻吻、颈部及躯干三部分组成。翻吻长度约 4 mm,躯干长度约 7.5 mm,翻吻与躯干长度之比接近 1∶2。

翻吻最大宽度为 3.8 mm,表面具吻突。在正模上有部分吻刺保存(插图 1c),在翻吻前后部均可见。单面至少约 10 列吻刺。单个吻刺基部宽度约 0.3 mm。单面每列吻刺数量约为 10 个。翻吻未缩进躯干内。

颈部窄而短,为翻吻与躯干之间的连接部位(插图 1d)。颈部长度仅 0.5 mm。表面未见任何装饰及构造。

躯干呈桶形,中部略鼓。最前端宽度为 3 mm,中部最宽处为 4.4 mm,末端宽度稍窄,为 2.2 mm。隔板保存稍差,纵向窄,正负模上均可见,以正模上保存较好。在正模躯干前部左上方可见 4 列纵向的隔板(插图 1c),该区域宽度为 1 mm。在此水平方向躯干宽度为 3.7 mm,根据比例可推断整个躯干纵向隔板数量大致为 15 列。在副模的躯干前部的隔板之间还见有密集的细小纵纹(插图 1e)。

肠道在躯干部位十分明显,因内部充填沉积物呈三维立体状,占据躯干部约 70%的位置(插图 1a,1b)。肠道宽度 0.5—0.7 mm。肠道由上而下盘旋 7 圈。相邻圈之间可相互叠置或被沉积物隔开。肠管的总体长度远远大于虫体的总长。

肛门位于躯干末端。躯干后端圆,未观察到尾突及类似的构造。

产地层位　云南省昆明市官渡区广卫村,寒武系下部乌龙箐组 *Palaeolenus* 带。

比较　当前标本在躯干表面纵向隔板数量、盘旋状的肠道等方面与产自澄江动物群的模式种 *Sicyophorus rara* 十分相似,主要区别在于前者翻吻与躯干长度之比接近 1∶2,颈部未见颈刺,而 *S. rara* 翻吻与躯干长度之比则接近 1∶1,吻刺仅见于翻吻前半部,颈部发育有一圈颈刺。产自澄江生物群的另一种葫芦虫类 *Palaeopriapulites parvus* 翻吻与躯干长度之比虽然也接近 1∶1,但其躯干表面具刺,未见纵脊或者兜甲,肠道细而直,明显区别于当前标本。凯里生物群的葫芦虫仅简要报道(赵元龙等,2011;Zhao *et al.*,2005),尚未经过详细的研究。从目前已经发表的图片来看(Figs. 7—8, Plate Ⅱ in Zhao *et al.*,2005;赵元龙等,2011,图 62—63),其躯干表面的纵列隔板数目约 40—50 列,远多于当前标本及澄江生物群 *S. rara* 的 20 列隔板。当前标本很可能为葫芦虫类的一个新种,由于标本数量仅有一枚,故暂时将当前标本归为葫芦虫属未定种。新种的命名尚待更多标本的发现及部分关键特征的确认。

3　结　论

葫芦虫类在关山生物群的发现,增加了关山生物群曳鳃动物及相关类型的多样性。目前关山生物群已经报道的曳鳃动物及相关类型包括 6 个古蠕虫

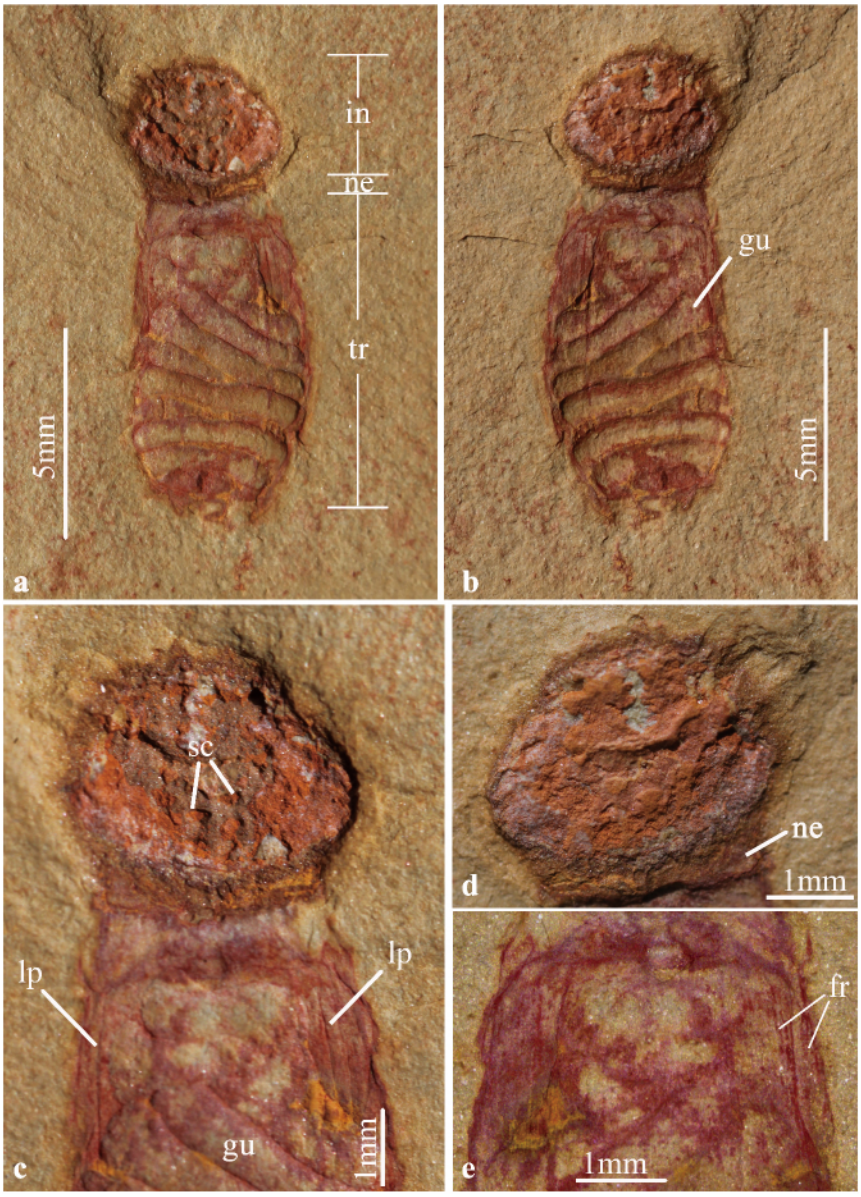

插图 1 关山生物群葫芦虫化石 *Sicyophorus* sp.

Sicyophorus sp. from the early Cambrian Guanshan Lagerstätte, Gaoloufang, Kunming City, Yunnan Province

a. **正模**, b. **副模**, c. **正模翻吻和躯干前部放大**, d. **副模翻吻及颈部放大**, e. **副模躯干前部放大**。**缩写**: fr. **纵向细纹**, gu. **肠道**, in. **翻吻**, lp. **纵向隔板**, ne. **颈部**, sc. **吻刺**, tr. **躯干**。

a. Part, b. counterpart, c. enlargement of the introvert and anterior part of the trunk, d. enlargement of the introvert and neck of the counterpart, e. enlargement of the anterior part of the trunk, showing the fine ridge. The following abbreviations are used: fr. : fine ridges, gu. : gut, in. : introvert, lp. : longitudinal plates, ne. : neck, sc. : scalids, tr. : trunk.

类(Hu *et al*., 2008, 2012; Liu *et al*., 2016)、**1 个棒形虫类**(Hu *et al*., 2012)、**1 个曳鳃虫类**(Hu *et al*., 2017)**和 1 个葫芦虫类,显示了较高的形态分异度及多样性。除澄江生物群和凯里生物群外,关山生物群是目前为止第三个发现葫芦虫的化石群,说明葫芦虫很可能是华南寒武纪特有的物种,具有明显的土著色彩。目前在澄江生物群、关山生物群发现的葫芦虫化石都见到明显的呈三维立体保存的肠道,证实葫芦虫肠管沉积物充填是普遍现象,不能简单地用动物死后沉积物充填来解释,说明该类动物很可能以食沉积物为主。**

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OCCURRENCE OF *SICYOPHORUS* FROM THE EARLY CAMBRIAN GUANSHAN BIOTA

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Key words *Sicyophorus*, Guanshan biota, early Cambrian, Yunnan

Abstract

A single individual of sicyophorids is discovered from the early Cambrian Guanshan biota in Yunnan, South China. The new finding represents the third occurrence of sicyophorids following the Chengjiang Lagerstätte (Cambrian Series Ⅱ, Stage 3) and the Kaili Lagerstätte (Cambrian Series Ⅲ, Stage 4), providing new information of the lifestyle and evolution of this animal group. Limited geographic distribution of sicyophorids indicates that this group is probably an endemic clade of the Cambrian fauna.

SYSTEMATIC PALEONTOLOGY

Class and order uncertain

Family Sicyophoridae Luo and Hu in Chen *et al.*, 2002

Genus *Sicyophorus* Luo and Hu, 1999 in Luo *et al.*, 1999

***Sicyophorus* sp.**

(Text-figure 1)

Material Only a single individual with internal and external moulds, NIGPAS167700, has been discovered and made available for this study. The specimen is deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China (NIGPAS prefix).

Description The introvert is swollen and oval-shaped. At least 10 rows of scalids present on one side of the introvert. The neck is narrow, locating between the introvert and the trunk. No spines or other ornaments are observed. The trunk is barrel-shaped, with a maximum width at the middle part. A total of 15 longitudinal plates is estimated. Numerous fine longitudinal ridges present between the plates. The gut is distinct and heavily coiled, filled with sediment, occupying about 70% of the trunk. No caudal appendages present.

Occurrence Guangwei Village, Kunming City, Yunnan, China. *Palaeolenus* Zone, lower part of the Wulongqing Formation, Cambrian, Stage 4.

Discussion The new specimen probably represents a new species of *Sicyophorus*. Further assignment at the species level is not attempted herein due to the limitation of information from the single specimen. Thus, the specimen is tentatively assigned herein to *Sicyophorus* in open nomenclature.

The discovery of sicyophorid fossil from the Guanshan biota adds a new element to the list of Guanshan priapulids, and increases our understanding of the diversity and disparity of priapulids and related groups in the marine communities during Cambrian Stage 4. So far, 6 paleocolecidians, 1 corynetiids, 1 xiaoheiqingelids, and 1 sicyophorids have been documented from the Guanshan biota, showing a high level of both diversity and disparity of priapulids and related groups.

To date, sicyophorids have not been recorded in other Cambrian deposits outside South China, and could therefore be considered as an endemic clade. However, further work is needed to confirm this hypothesis.