DOI:10.19800/j.cnki.aps.1994.03.005

第33卷 第3期 古 生 物 学 报 Vol. 33, No. 3
1994年5月 ACTA PALAEONTOLOGICA SINICA May, 1994

贵州台江凯里动物群中的棘皮动物

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内 容 提 要

早、中寒武世的棘皮动物化石在我国尚属首次报道,贵州台江凯里组中部(中寒武统)的棘皮动物包括海百合亚门(Crinozoa)始海百合纲的1新科、3新属、7新种和海扁果亚门(Homalozoa)海箭纲的1个未定属种。这些化石个体较小,茎、萼、腕比较发育,萼板较少,缝孔一般发育,普遍具有小瘤突(epispires),未见固着器,与北美及东欧波希米亚地区下、中寒武统始海百合纲化石组合特征有明显的差异。

关键词 棘皮动物始海百合纲 海扁果亚门 中寒武统 贵州台江

一、前 言

贵州台江革东八郎下、中寒武统凯里组的棘皮动物化石是凯里动物群的重要组成部分,标本数量十分丰富,经鉴定,绝大部分是始海百合纲化石,共7新种:*Sinoeocrinus lui* sp. nov., *S. curtobrachiolus* sp. nov., *S. lepidus* sp. nov., *S. longus* sp., *S. minor* sp. nov., *Paragogia globus* sp. nov., *Curtoeocrinus guizhouensis* sp. nov., 它们分别隶属于3属3科。此外,还有1个海扁果亚门箭石纲的未定属种。

笔者在研究过程中,曾得到已故穆恩之教授的关怀和鼓励;R. A. Robison 教授、张永辂教授、陈重泰教授等也给予诸多帮助;王长国摄制化石照片,熊蕴芝清绘插图。作者向他们致以衷心感谢。

二、棘皮动物始海百合纲一般特征

始海百合纲(Eocrinoidea)是棘皮动物海百合亚门中最原始的一个纲,始现于早寒武世,灭绝于志留纪,化石比较稀少。至1967年,共发现18属,其中寒武纪的占9属(Ubaghs, 1967,)。据不完全统计,1967－1992年寒武纪的始海百合纲中又建立了7个属(Jell *et al.*, 1985; Ubaghs and Robison, 1985; Рожнов и др., 1992)。至此,寒武纪始海百合纲化石的属至少为16个。其分布范围较广,以北美、波希米亚、西伯利亚为主,次为澳大利亚、波兰、法国、西班牙。

始海百合纲化石往往以单体出现,完整的个体包括3部分,即茎(stem, stalk, column)、萼(theca, calyx)及腕(brachioles),其中茎可以不发育或缺失。具腕的一端为口面(oral surface),具茎的一端称为反口面(aboral surface)(插图2)。

茎是一个中空的管状构造，管壁由许多大小不等的多边形茎板组成。不同属种的茎具有不同的长度和粗细，有的属种茎的末端突然加粗变为固着器(holdfast)，和茎一样起着临时或永远固着身体于海底的作用。

萼呈梨形，椭球形，球形，亚筒形。它的外壁由许多萼板(thecal plates)组成，数量由20块至几百块，内部为内脏。萼板以多边形为主，一般无孔，少数有孔，但有的属两个萼板之间的缝合线上有孔，称为缝孔(sutural pores)。缝孔的形态有圆形，椭圆形，长椭圆形，长沟状，显示着缝孔发育程度的加深。此外，萼板缝合线上或3个萼板交角处有一些小瘤突(epispires)，可能起呼吸作用。具缝孔的萼板呈齿轮状、似齿轮状。萼板的排列方式有的属种较规则，有的不规则，有些属种萼板规则排成环状。萼板由反口面向口面可分为底板(basal plates)，下侧板(infralateral plates)，侧板(lateral plates)，辐板(radial plates)，上辐板(supraradial plates)，肛板(anal plates)及其他性质的萼板。萼的顶部为口面(oral surface)包括口(oral)，食物沟(food groove)，连接腕的板(brachioliferous plates)，盖板(cover plate)等构造。

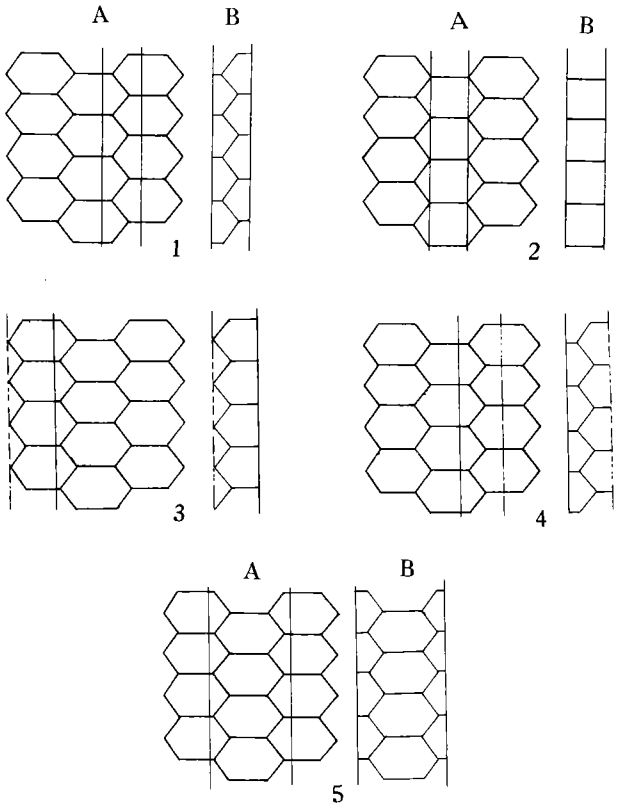

插图1 腕因保存时处于不同位置而形成的各种侧视形态

Various lateral view of brachioles

A. 腕展开图及侧压位置图；

B. 不同侧压位置形成不同的侧视形态

腕是附在萼部的简单的管状附肢，具有运送食物的功能，由多边形腕板规则排列而成，由于形成化石时处于不同的部位，侧视时呈现不同的形态，有的腕侧视边缘呈刺状或三角状(插图1)。不同的属种腕的枝数、长短也不同，有的属种腕分枝，有的则不分枝。

始海百合纲与海林檎纲关系较为密切，其萼部构造、腕的构造及作用、步带构造(高级的种类才具有)与海林檎纲更为相似(Ubaghs，1967，p. 474—475)。

1967年，Ubaghs将始海百合纲分为4目7科，经Sprinkle以及Рожнов等(1992)的研究，又增加了新目、新科。始海百合纲内目、科、属、种的分类依据，Ubaghs曾提出4点特征(1967，p. 478)：(1)萼板的数目及排列方式；(2)缝孔的出现或消失；(3)萼的对称性；(4)腕的性质。作者认为这4点特征用在科、目的划分上比较适用，而用于属、种的划分还应更加具体些。

三、台江凯里组始海百合纲化石特征

1. 化石保存状况

台江革东八郎凯里组中部为青灰色、灰绿色粉砂质泥岩、泥岩、粉砂质钙质泥岩及少量泥质粉砂岩，棘皮动物化石层主要有 2 层，下部层位的始海百合纲化石属种数量较少也较单调，主要是 *Sinoeocrinus* gen. nov. 的 3 种，即 *S. longus* gen. et sp. nov.，*S. lepidus* gen. et sp. nov.，*S. minus* gen. et sp. nov.，这些属种的个体较小，萼板数较少，腕枝多为 4 枝；上部层位中的始海百合纲化石数量多，个体较大，属种多，有时化石密集分布，在 8cm×6cm 的三角形泥质粉砂岩层面上有 14 个完整的(构造保存不佳)个体，排列方向一致或近于一致，很可能是原地埋葬的结果。由于化石保存在泥岩中，易风化，萼部常呈现内部构造或印模，实体标本很少。萼板也散见于围岩，呈齿轮状、菊花瓣状。由于绝大部分始海百合纲化石以侧视形态出现，口面构造不易显现，口及附近的构造研究十分困难，未能了解清楚。众多完整的化石个体中，有 1 块两个个体相连的标本，它们个体小，茎尾上翘而联结在一起(图版 Ⅲ，图 3；插图 6)，这种现象十分罕见，有待深入研究。

和始海百合纲化石共生的有三叶虫 *Pagetia*，*Kaotaia*，*Oryctocephalus*，*Olenoides*，*Peronopsis* 以及水母状化石、腕足类、藻类等。凯里组下部也见有棘皮动物化石萼板。

2. 化石组合特征

所描述的 3 属 7 种始海百合化石，除了 Lichenoididae 的 *Curtoeocrinus* 外，其他各属种均具有茎，个体长度一般在 10—30mm，偏小。萼为卵形、梨形、球形，由不完整的六边形及多边形萼板组成。萼板数目在 32—50 块之间变化，板体大小排列有规则，萼中部的侧板最大，长度可达 1.90mm。向口面及反口面萼板减小。萼板排列规则，呈环状或斜向环状。3 属的缝孔发育程度有明显的差异，*Sinoeocrinus* 属的 5 种的缝孔发育一般，呈小圆形，主要由于 epispires 造成，类似于 *Rhopalocystis* 式缝孔(Ubaghs，1967，p. 466，fig. 300，2a)，不同的是 *Sinoeocrinus* 的萼板之间的缝合线上无缝孔，我们把这种仅由萼板交汇处 epispires 形成的缝孔称为 *Sinoeocrinus* 式缝孔，这也是建立 Sinoeocrinidae fam. nov. 的主要依据之一。*Curtoeocrinus* gen. nov. 的缝孔较为发育，类似 *Akadocrinus* 式的(Ubaghs，1967，p. 466，fig. 300，1)。*Paragogia* gen. nov. 的缝孔最为发育，裂为较长的通道，位于通道中间缝合线位置上还有小瘤突(epispires)(插图 7)，这种缝孔基本上属于 *Lichenoides* 式的缝孔(Ubaghs，1967，p. 467，fig. 301，1a)。台江凯里组始海百合纲化石的腕枝数在 4—12 枝之间，少数属为 *Curtoeocrinus* 分枝，其他属种基本上不分枝。腕由多边形腕板规则排列而成。北美下、中寒武统普遍发育的 *Gogia* (Robison，1965，p. 358—362；Ubaghs，1967，p. 478；Sprinkle，1976，p. 62—68；Paul and Smith，1984，p. 457—466)的种已超过 10 个(Smith，1988，p. 810—811)，该属萼板多，最多的达 500 块(Robison，1965，p. 358)，大小相间，基本上不规则排列；缝孔很发育；具有小瘤突；腕多，少则 8 枝，多至 22 枝，最多的达 44 枝；茎多呈粗柱状，少数末端加粗形成固着器。北美中寒武统的 *Eocystites* (Bather，1918，p. 49—56；Ubaghs，1967，p. 493)没有明显的腕，萼板中部隆凸。此外，北美中寒武统还有一些萼部无缝孔和具小瘤突的属，如 *Marjumicystis* Ubaghs et Robison，*Eustypocystis* Sprinkle，*Molichuckia* Sprinkle，*Trachelocrinus* Sprinkle，它们的萼板排列不规则，或是无茎，具有固着器。由此可见，北美下、中寒武统始海百合纲化石属种丰富，和台江的组合面貌有明显的差别。东欧波希米亚地区中寒武统所产的

Akadocrinus Prokop, *Acanthocystites* Barrande, *Lichenoides* Barrande 等始海百合化石，都具有发育的缝孔构造和小瘤突，缝孔开口于横穿萼板之间缝合线的狭长通道里；腕多，与台江的始海百合纲化石组合面貌也有差异。

此外，台江凯里组中部有一些始海百合纲化石的碎片，以及一些完整标本的茎、萼板，中央有 1—5 个小孔，这可能是海林檎类化石。

3. 研究意义

北美及东欧波希米亚地区下中寒武统始海百合纲化石特别丰富，其中 *Gogia* 属的分子很多，分布很广，并成为某些地区划分下中寒武统的主要化石(Robison, 1965)。我国寒武系中曾发现过棘皮动物化石或碎片，薛耀松等(1992)在报道贵州陡山沱组海百合茎化石时也提到湖北、安徽下寒武统岩石薄片中见有棘皮动物化石碎片，但均无正式记述。因此，本文报道的贵州台江下中寒武统凯里组中部棘皮动物化石在我国尚属首次。产棘皮动物化石的台江位于早、中寒武世扬子区与江南区之间的过渡区(卢衍豪等，1974；周志毅等，1979，1980)。属于这个过渡区的铜仁*(中寒武统)及湘西**(上寒武统)都发现了棘皮动物化石，说明我国华南寒武纪过渡区因有同样的沉积环境，有进一步发现更多棘皮动物化石乃至凯里动物群的可能。已发现的始海百合纲化石形态、构造多种多样，具缝孔构造的和不具缝孔构造的均有，已造成分类上混乱。Ubaghs(1967，p. 456)指出始海百合纲包括了一些异源组合分子，并预料可能要进行再划分。台江始海百合纲化石的发现及研究，丰富了始海百合纲的内容，增加了一个产出地区，为始海百合纲的系统分类及古生物地理研究提供了很好的资料。

四、属种描述

棘皮动物门 Echinodermata

海百合亚门 Crinozoa Matsumoto, 1929

始海百合纲 Eocrinoidea Jaekel, 1918

中国始海百合科(新科) Sinoeocrinidae fam. nov.

模式属 *Sinoeocrinus* gen. nov.

特征 个体小至较小，一般长度在 10—30mm，具腕、萼、茎，腕及茎相当发育。萼呈梨形、椭球形、卵球形。萼板多边形，去掉缝孔位置呈浅齿轮状。3 个萼板相交处有 epispires，这个 epispires 实际上起到缝孔的作用，两者合二为一，称中国始海百合式缝孔。萼板排列规则或比较规则。口部构造不清楚。腕 4—12 枝，较长，由多边形萼板组成。茎长或比较长，管状。

讨论 新科和 Eocrinidae 科(Ubaghs, 1967, p. 478)比较相似，区别是后者萼板数多，排列不规则；缝孔发育，常呈长椭圆形；腕枝多，在口面周围簇生。下奥陶统的 Rhopalocystilce 科(Ubaghs, 1967, p. 481, fig. 300, 2a; fig. 310)的萼板交汇处有缝孔，萼板排列也较有规则，和新科有些相似，但后者萼板多，萼板之间的缝孔线上也有缝孔，腕多达 20—30 枝，区别明显。

时代分布 中寒武世；贵州。

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* 赵元龙等 1992 年 12 月采集。

** 彭善池博士面告并见有标本。

中国始海百合属(新属)　*Sinoeocrinus* gen. nov.

模式种　*Sinoeocrinus lui* gen. et sp. nov.

特征　个体较长，中等大小，具有发育的茎、萼、腕。正模标本长 26.50mm。萼纵切面呈卵圆形或呈倒灯泡形。最大宽度位于萼中上部或近顶部位置。萼板多边形，但以六边形为主，具缝孔的呈浅齿轮状。3 个萼板交汇处具小瘤突 epispires，具有缝孔作用，两者合二为一，称中国始海百合式缝孔。萼板总数在 32－50 之间，排列有规则，呈水平环状或斜环，可分为底板、下侧板、侧板及辐板。腕 4 枝以上，最多 12 枝，由多边形腕板规则排列而成，并形成很多侧视形态(插图 1)。茎长或比较长，由许多多边形茎板排列成 3－5 列组成。

讨论　新属最主要特征是萼板较少；排列规则；缝孔一般发育，具中国始海百合式缝孔；茎长，由许多多边形茎板较规则排列组成。而广泛分布于北美、法国及澳大利亚下、中寒武统的 *Gogia* (Robison, 1965, p. 358－362.; Ubaghs, 1967, p. 478.; Sprinkle, 1976, p. 62－68.; Paul *et al.*, 1984, p. 457－466)具有较多的多边形萼板，最多达 500 块；排列不太规则；缝孔发育，呈长椭圆形或长沟状；腕多，8－22 枝；茎呈粗柱状，由许多茎板不规则排列而成。美国犹他州中寒武统 Marjum 组的 *Marjumicystis* (Ubaghs *et al.*, 1985, p. 19－22, fig. 15, 16)的萼板多边形，排列不规则，无缝孔及小瘤突，腕短，无茎，与新属区别明显。北美中寒武统上部的 *Eustipocystis* 具茎，萼板多边形，和新属有相似之处，但前者萼板小，排列不规则，无缝孔及小瘤突。

时代分布　中寒武世，贵州。

卢氏中国始海百合(新属、新种)

***Sinoeocrinus lui* gen. et sp. nov.**

(图版 Ⅰ，图 1；图版 Ⅱ，图 1；插图 2)

材料　15 块完整个体标本。

描述　个体具腕、萼、茎，中等大小，长度在 22.00－35.00mm，正模标本长 26.50mm，其中茎长 7.55mm，萼长 7.50mm。萼椭球形，口面较宽圆，反口面较窄，呈倒圆锥形，最大宽度位于萼的中上部，与萼长之比为 1∶1.3。萼板 44－50 块，以六边形为主，较大，最大的位于萼的中部，长度近于 2.00mm，基本相间排列和环状排列，规则。由反口面向上可分为底板、下侧板、侧板、辐板，上辐板、间辐板等较小，保存又欠佳，一般不易区别。萼板缝合线上未见明显的缝孔，但缝合线中间有极小的未穿越边缘的小孔(插

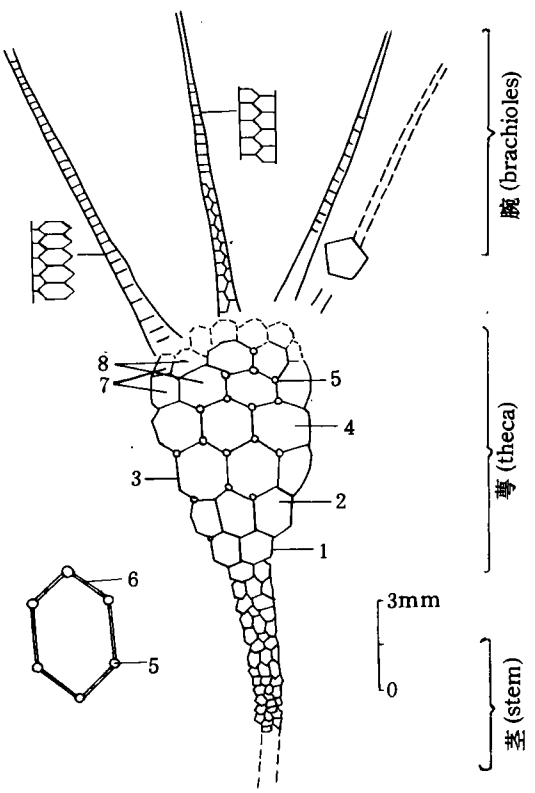

插图 2　*Sinoeocrinus lui* gen. et sp. nov.
1. 底板(basals)；2. 下侧板(infralaterals)；3. 侧板(laterals)；4. 辐板(radials)；5. 小瘤突(epispires)；6. 萼板边缘中(放大)的小孔(pore)

图1,6)。3个萼板交汇处有小瘤突,起呼吸作用,实际上起缝孔作用,由于小瘤突的存在,六边形的萼板不完整,成了浅齿轮状(插图1)。腕4—12枝,很长,模式标本上见最长的1枝达11.00mm,由多边形腕板规则排列而成。茎长,近反口面处较粗,向末端缓慢变细;中空,由多边形大小不等茎板较有规律地排列而成。

比较 同属。

产地层位 贵州台江革东;下、中寒武统凯里组中部。

短腕中国始海百合(新属、新种) ***Sinoeocrinus curtobrachiolus* gen. et sp. nov.**

(图版Ⅱ,图3,4;插图3)

材料 完整个体标本5块,其中实体标本1块,印模内部构造标本4块。

描述 个体较小,长10.00—18.00mm,正模标本个体长15.60mm。萼呈高杯状,由六边形为主的多边形萼板组成,最大萼板位于萼的中部,长1.50mm。萼板总数约40—46块,呈环状排列,可明显分出底板(5块)、下侧板(5块)、辐板(8块)及肛门板。具小瘤突及中国始海百合式缝孔。可见口部,腕由口四周伸出,较短而弯曲。茎较粗,由6列多边形茎板相间排列而成。

比较 当前新种与 *Sinoeocrinus* 的模式种 *S. lui* gen. et sp. nov.(本文图版Ⅰ,图1;图版Ⅱ,图1;插图2)最为相似,区别是新种个体较小;腕枝短而弯曲;茎较粗而短。

产地层位 贵州台江县革东;下、中寒武统凯里组中部。

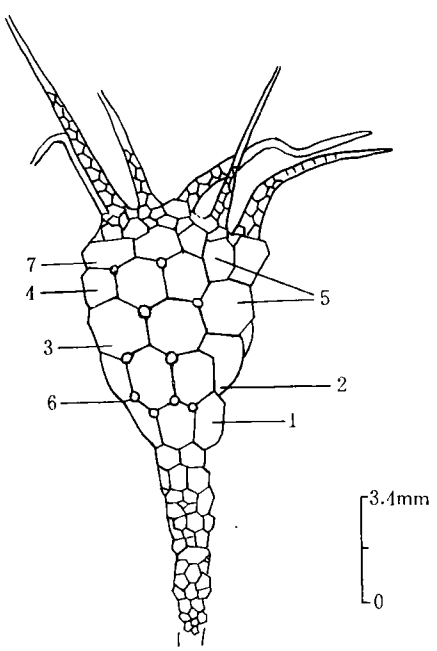

插图3 *Sinoeocrinus curtobrachiolus* gen. et sp. nov.

1. 底板(basals);2. 下侧板(infralaterals);3. 侧板(laterals)4. 辐板(radials);5. 肛板(anals);6. 小瘤突(epispires);7. 腕(brachioles)

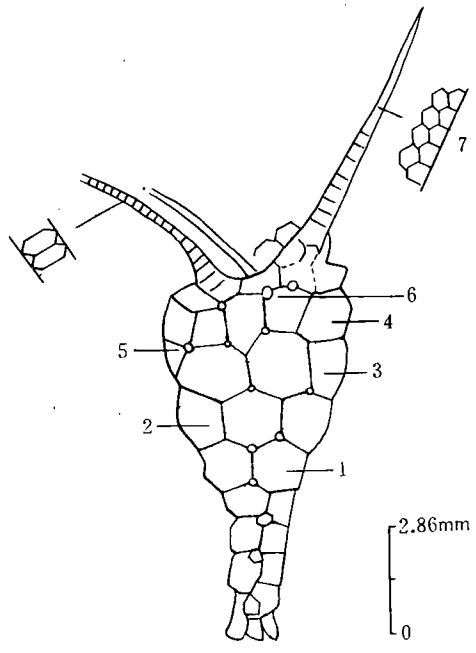

插图4 *Sinoeocrinus lepidus* gen. et sp. nov.

1. 底板(basals);2. 下侧板(infralateral);3. 侧板(lateral);4. 辐板(radial);5. 小瘤突(epispires);6. 缝孔(sutural pores);7. 部分腕放大

整洁中国始海百合(新属、新种)　*Sinoeocrinus lepidus* gen. et sp. nov.

(图版Ⅳ,图 3,6,8;插图 4)

材料　完整个体标本 12 块,为内部构造及印模。

描述　个体较小,长度在 15.00－24.00mm 之间,正模标本长 17.20mm。萼椭圆形,最大宽度位于萼部中上部位置,正模标本萼长 6.50mm,宽 4.50mm,长宽之比为 3:2。萼板 36－40 块,排列规则,呈环状。由于 3 个萼板交汇处有小突瘤,萼板实际上呈浅齿轮状,但基座仍为完整的多边形。由反口面向口面,萼板可分为底板(4)、下侧板(5－6)、侧板(5－6)、辐板(8－10),最大萼板位于萼的中部。腕 4 枝,常向两个方向伸展,由多边形腕板规则排列组成。茎较粗而短,短于萼的长度,由 4 列茎板组成,基底则为 6 块茎板组成。

比较　当前新种与 *Sinoeocrinus* 的模式种 *S. lui* gen. et sp. nov.(本文图版Ⅰ,图 1;图版Ⅱ,图 1;插图 2)相比,后者萼板较多,小瘤突较发育,腕多而长;茎细长,由 6 列茎板组成。当前新种与 *S. curtoeocrinus* gen. et sp. nov.(本文图版Ⅱ,图 3,4;插图 3)的区别是后者萼板较多,小瘤突较发育;腕枝多而弯曲,茎长,由 6 列细小茎板组成。

产地层位　贵州台江革东,下中寒武统凯里组中部。

长形中国始海百合(新属、新种)　*Sinoeocrinus longus* gen. et sp. nov.

(图版Ⅳ,图 2,4,7;插图 5)

材料　有完整印模、内部构造的标本 10 块;不完整的 12 块。

描述　个体较小,萼和茎的长度(由于腕多平伸,故以萼和茎的长度来表示)一般在 14.00－18.00mm,正模标本 15.20mm。萼呈椭圆形,最大宽度位于萼近顶部处,正模标本萼宽约 4.50mm,长 7.00mm,宽长比为 1:1.56。萼板多边形,以六边形为主。萼板交汇处的小瘤突很少发育。萼板比较完整,最大萼板长 1.25mm,位于萼的中部,萼板排列规则,基本上呈环状,由反口面向上可分底板(5)、下侧板(5)、侧板(4)、辐板(4)及肛板,总数在 40 块左右。缝孔发育差。腕 4 枝,正模标本上的 4 个枝,1 枝未完全暴露,1 枝压在萼部上;另 2 枝较长,其中 1 枝长 9.60mm,一侧呈刺状,这是由于保存边缘正好穿过多边形中部所致(插图 1,4)。茎细长,略超过萼的长度,中空,由多边形萼板规则排列组成,由萼底部向末端缓慢变细。少数茎板有 1－3 个孔穿透。

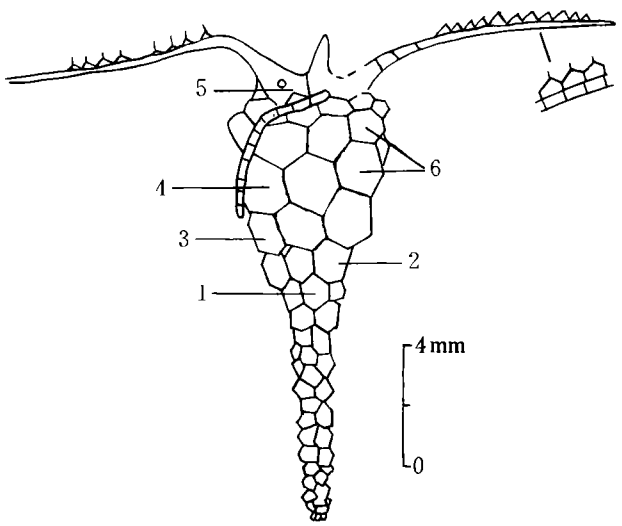

插图 5　*Sinoeocrinus longus* gen. et sp. nov.
1. 底板(basals);2. 下侧板(infralateral);3. 侧板(lateral);
4. 辐板(radial);5. 口部(mouth);6. 肛板(anals)

比较　新种和模式种 *Sinoeocrinus lui* gen. et sp. nov.(本文图版Ⅰ,图 1;图版Ⅱ,图 1;插图 2)都具

有较长的腕、萼、茎及多边形的萼板，区别是前者萼板少，缝孔及小瘤突均不发育。腕枝少，平伸或斜伸；茎细长，仅由4列茎板组成，茎板上具有穿透的小孔。当前新种与北美中寒武统的 *Eustipocystis* (Ubaghs and Robison, 1985, p. 21)相比，后者萼板小，排列不规则，茎短，区别明显。新种正模标本的茎中部3块茎板具有穿透的小孔，同一层另一标本的正、副模(GTB-13-1-1-a, GTB-13-1-1-b)不仅具有穿透的小孔，而且小孔的数目可至3个。Ubaghs(1967)和 Robison(1965)都曾指出某些始海百合属种具有萼板孔(thecal pore)是正常的现象。新种茎板出现茎板孔，其性质也是一样的，也是进化的表现。

产地层位 贵州台江革东；下、中寒武统凯里组中部。

小型中国始海百合(新属、新种) *Sinoeocrinus minus* gen. et sp. nov.

(图版Ⅲ，图1—5；插图6)

材料 共有标本7块，完整个体5块，其中有2个个体相连的标本。

描述 个体小，正模标本(GK1707，左侧个体)长7.30mm。具茎、萼、腕，萼长2.40mm，切面近于倒梯形，最大宽度位于萼顶稍下处，宽度与长度几乎相等。萼板少，约32—36块，由底板(5)、侧板(6)、辐板(6)、上辐板及肛板等组成。缝孔及小瘤突均很少。腕4枝左右，模式标本上最长的一枝可达4.50mm，由多边形腕板规则排列而成。由于腕保存边缘穿过多边形腕板中部，侧视多呈刺状。茎锥形，正模标本近反口面萼的底部宽0.55mm，末端0.22mm。茎中空，由多边形茎板规则排列而成，基本上相间排列。正模标本的2个个体以茎末的茎板互相连结，连接处上翘(图版Ⅲ，图3；插图6)。

讨论 新种和 *Sinoeocrinus longus* gen. et sp. nov.(图版Ⅳ，图2，4，7；插图5)的萼板数量、性质、缝孔及小瘤突的发育程度、腕枝数量等十分相似，而与 *S. lui*, *S. curtobrachiolus*, *S. lepidus* 有

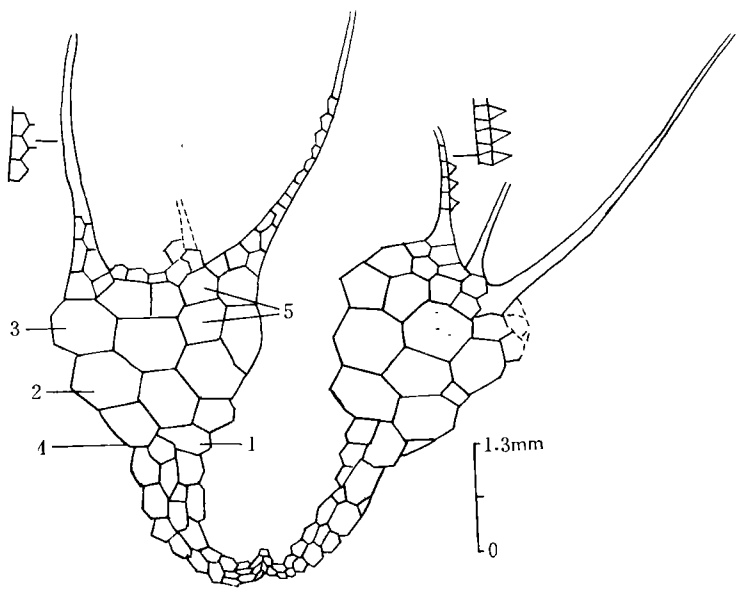

插图6 *Sinoeocrinus minus* gen. et sp. nov.

1. 底板(basals)；2. 侧板(laterals)；3. 辐板(radials)；4. 小孔(pore)；5. 肛板(anals)

较明显的区别，说明新种与 *S. longus* 的关系最为密切。新种和 *S. longus* 的区别是后者萼部椭圆形，腕斜伸，茎细长，锥管状。北美中寒武统的 Eustipocystis (Ubaghs and Robison, 1985, p. 21) 具腕、萼、茎，萼板多边形，无缝孔和小瘤突，和当前新种有些相似，区别是新种萼板较小，排列无规律，茎短。

新种的缝孔稀少或很不发育。但在某些萼板的缝合线上见有小孔(插图 6-4)，但真实情况不详，有待于进一步采集标本研究解决。

产地层位　贵州台江革东；下、中寒武统凯里组中部。

始海百合科　Eocrinidae Jaekel, 1918

拟戈氏海百合(新属)　*Paragogia* gen. nov.

模式种　*Paragogia globosa* gen. et sp. nov.

特征　个体大或较大，模式种的正模标本仅萼和茎的长度就达 35.00mm，暴露出来的最长腕枝达 20mm。萼近于球形、梨形，最大宽度位于萼的中部。萼板排列呈环状，可分出底、下侧板、侧板及辐板。缝孔很发育，较狭长，狭长通道中两萼板缝合线上还有小瘤突，近似于 lichenoides 型的缝孔(Ubaghs, 1967, p. 466, fig. 300, 1)。腕 8 枝以下，较长而弯曲，在萼的顶部簇生或分叉；由多边形腕板规则排列形成。茎长而弯曲。

讨论　新属与广泛分布于北美及法国、澳大利亚等下、中寒武统的 *Gogia* (Robison, 1965, p. 358—362; Ubaghs, 1967, p. 478; Sprinkle, 1976, p. 62—68; Paul and Smith, 1984, p. 457—466)在外形、萼的形状、萼板及缝孔的性质、腕枝的数量上都有些相似，区别是后者萼板多，排列不规则，缝孔边具细脊；腕更多(8—22 枝)；茎粗而短，由不规则的茎板组成。新属与 *Sinoeocrinus* 都具有长腕和长茎，萼的外形也有些相似，但是后者的萼一般呈椭球形，缝孔一般发育，个体较小，较易区别。

时代分布　中寒武世早期；中国贵州。

球形拟戈氏海百合(新属、新种)　*Paragogia globosa* gen. et sp. nov.

(图版 Ⅰ，图 2；插图 7)

材料　完整印模及内部构造个体标本 4 块，破碎标本 2 块。

描述　个体大，一般长度 45.00—54.00mm，正模标本长 51.60mm。萼球形或倒灯泡形，最大宽度在中部，正模标本宽 14.50mm，长 16.00mm，宽长之比为 7:8。萼板 40—46 块，排列比较规则，呈环状，可分出底板(4)、下侧板(5)，侧板(6)，辐板(8)，其中侧板最大。萼板偶夹小萼板。缝孔发育，狭长，萼板之间的缝合线上有小瘤突(图版 Ⅱ，图 2；插图 7-5)，属于 Lichenoides 类型的缝孔(Ubaghs, 1967, p. 467, fig, 301-1)，萼板实际上呈菊花瓣状或齿轮状。腕多，直接由口部周围伸出，细而长，正模标本上的 1 枝腕长达 20mm，共有 8—12 枝。茎细长而弯曲，长度与萼长近等(15.80mm)；直径由近萼部向茎末端缓慢减小，由较小的大小相间的多边形茎板较有规律的排列而成。

比较　同属。

产地层位　贵州台江革东，下、中寒武统凯里组中部。

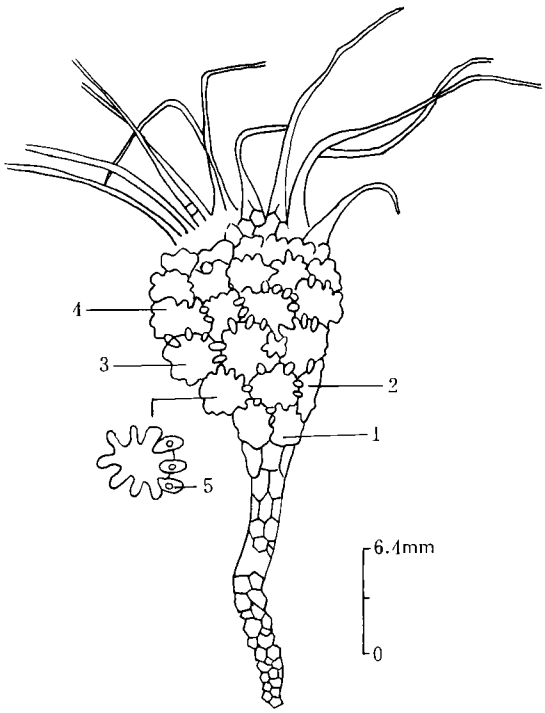

插图 7 *Paragogia globosa* gen. et sp. nov.
1. 底板(basals);2. 下侧板(infralaterals);3. 侧板(laterals);
4. 辐板(radials);5. 小瘤突(epispires)

不规则分裂海百合科 Lichenoididae Jaekel, 1918

短始海百合属(新属) *Curtoeocrinus* gen. nov.

模式种 *Curtoeocrinus guizhouensis* gen. et sp. nov.

特征 个体由腕及萼组成,未见茎。萼小,正模标本长 9mm 左右,卵圆形。萼由大萼板及若干小萼板组成,大萼板呈不规则齿轮状,数量不超过 14 个,组成底、中、上 3 个萼环,分别由底板、侧板及辐板构成。缝孔发育,椭圆形,属 Akadocrinus 式缝孔(Ubaghs, 1967, p. 466, fig. 100-1)。可见口,四周为具腕的板(brachioliferous plates)和其他性质的萼板。腕发育,由多边形的腕板规则排列而成,簇生或单独生长在口的周围,分枝或不分枝,共有 8 个以上的末枝。

讨论 新属无茎,形状独特,萼板稀少,缝孔发育,腕分枝,和始海百合纲大部分属很易区别。波希米亚中寒武统的 *Lichenoides* (Ubaghs, 1967, p. 460, fig. 295; p. 480—481, fig. 308)在无茎,萼板少,组成底、中、上 3 个环带,具发育的缝孔构造,腕枝多等方面与新属有些相似,但前者萼底环宽,个体葫芦形;缝孔裂成通道,狭长,属 Lichenoides 式的缝孔(Ubaghs, 1967, p. 480—481, fig. 295, 308),腕枝更多,部分直插在萼的中上部。

时代分布 中寒武世早期;中国贵州。

贵州短始海百合(新属、新种) ***Curtoeocrinus guizhouensis* gen. et sp. nov.**

(图版Ⅳ,图 1;图版Ⅴ,图 1—5;插图 8)

材料　6 块个体标本,其中 2 块完整;另有 10 多块萼板。

描述　个体由腕和萼组成,无茎,小,正模标本萼长 9mm。萼卵圆形,最大宽度位于萼的中上部,正模标本宽 6mm。萼由大萼板及若干小萼板组成,大萼板呈不规则齿轮状,数量不超过 14 个,形成底、中、上 3 个萼环,分别由底板(2)、侧板(4)及辐板(5—6)组成。缝孔发育,有大有小;大的椭圆形,每个萼板四周约有 6—8 个,属于 Akadocrinus 式缝孔(Ubaghs, 1967, p. 466, fig. 300-1)。可见口,四周为具腕的板和其他性质的萼板。未见口盖(也可能未保存下来)。腕发育,由多边形腕板规则排列组成,簇生或单枝生长在口的周围,普遍分枝,共有 8 个以上的末枝。正模标本上最长末枝达 9.00mm,和萼长近相等。

比较　同属。

产地层位　贵州台江革东;下、中寒武统凯里组中部。

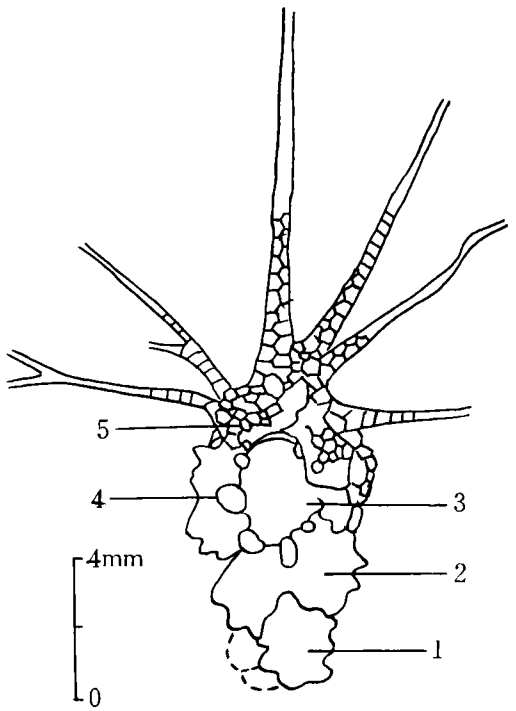

插图 8　*Curtoeocrinus guizhouensis* gen. et sp. nov.
1. 底板(basals);2. 侧板(laterals);3. 辐板(radials);
4. 缝孔(sutural pores);5. 口(mouth)

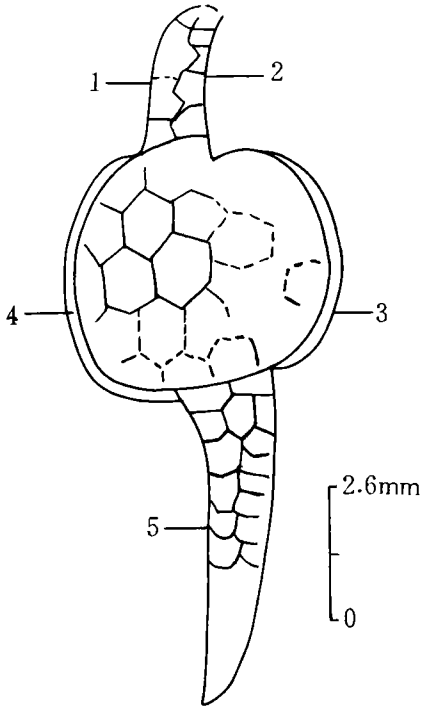

插图 9　fam. gen. et sp. indet.
1. 小腕(br.);2. 食物沟(fg.);3. 萼(theca)
4. 边缘板? (brim plate ?);5. 茎尾(stele)

海扁果亚门　Homalozoa Whitehouse, 1941

海箭纲　Homoiostelea Gill et Caster, 1960

科、属、种未定　fam. gen. et sp. indet.

(图版Ⅳ,图 5;插图 9)

材料　仅 1 块完整个体标本,保存良好,大部分构造比较清楚。

描述 个体较小，长 11mm。身体背腹扁平。萼似球形，由许多多边形萼板组成，其中以六边形为主；萼板较大，中部最大的萼板长 0.67mm；排列比较规则。萼的左右侧存在边缘板。萼左前侧位置有较粗的臂，由一些多边形的板组成，中部有弯曲的食物沟。萼后端有一个较长的茎尾，由双列多边形茎板组成。

比较 当前标本和 *Castericystis vali* (Ubaghs and Robison, 1985, p. 1—17, figs. 1—12)有些相似，但后者萼部椭球形，没有边缘板；腕和茎尾的板多而小。由于当前标本仅有 1 块，局部保存欠佳，暂作属、种未定处理。

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ECHINODERM FOSSILS OF KAILI FAUNA FROM TAIJIANG, GUIZHOU

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Key words echinoderm (eocrinoid) fossils, Taijiang, Guizhou, Middle Cambrian, Kaili Fauna

Summary

The Cambrian echinoderm fossils described in this paper were first discovered by the authors in 1982 from the middle part of the Kaili Formation (Lower—Middle Cambrian) in Taijiang County, Guizhou, Southwest China. Since then, more than 90 specimens have been successively collected by the authors from the same locality and the same horizon. These echinoderm fossils consist of 7 new species and 1 inderteminable species, belonging to 3 new genera, 3 families including 1 new family, 2 classes and 2 subphyla. The new taxa are identified as *Sinoeocrinus lui* gen. et sp. nov., *S. curtobrachiolus* gen. et sp. nov., *S. longus* gen. et sp. nov., *S. lepidus* gen. et sp. nov., *S. minus* gen. et sp. nov.; *Paragogia globosa* gen. et sp. nov.; *Curtoeocrinus guizhouensis* gen. et sp. nov. and Sinoeocrinidae fam. nov.

As the oldest class of all known Crinozoa, the Eocrinoidea appeared in Early Cambrian and became extinct in the Silurian, mainly characterized by the absence of thecal plate pores, the presence of sutural pores and epispires in sutures between thecal plates in many genera. The Cambrian eocrinoids include about 16 genera up to 1992 (Ubaghs, 1967; Sprinkle, 1973; Ubaghs and Robison, 1985; Jell *et al.*, 1985; Smith, 1988; Рожнов и др., 1992). The Lower and Middle Cambrian fossil

eocrinoids are widely distributed in North America, Bohemia, Siberia, France, Poland, Australia, *etc.*

Except *Curtoeocrinus*, these fossil eocrinoids in the Middle Cambrian of Taijiang possess well-developed stems. The theca is spheroidal, ovoid and pyriform. The thecal plates are polygonal, relatively large, numbering 32—50 in most species, and regularly arranged in successive circlets, as a rule, in alternation. In the two genera *Curtoeocrinus* and *Paragogia*, the sutural pores are well-developed, but in *Sinoeocrinus*, they are moderately developed, small in size, located at top of the angle of polygonal thecal plates, overlapping with epispires in position. *Sinoeocrinus* differs morphologically from *Rhopalocystis* chiefly in the absence of sutural pores in the sutures between thecal plates; it has 4—12 brachioles. The Lower—Middle Cambrian *Gogia* Walcott (Walcott, 1917, p. 27; Robison, 1965, p. 358—362; Ubaghs, 1967, S. 478; Sprinkle, 1976, p. 62—68; Paul and Smith, 1984, p. 457—466) is widely distributed in North America, France and Australia, including more than 10 species (Smith, 1988, p. 810—811). In *Gogia*, the thecal plates are polygonal in shape, irregularly arranged, possibly numbering up to 500 in some species; the sutural pores are abundant in number, with deeper indentations; the epispires are extensively developed in some species; the brachioles are long, slender, numbering 8—22 and possibly up to 44, probably originating in clusters each with two or three of them and they are spiral in some species; the stem is composed of numerous smaller irregularly arranged polygonal plates enclosing an elongate central cavity, with apparent holdfast at the distal end in some species (Robison, 1965, p. 358—360). The Lower Cambrian *Eocystites* Billinges (Bather, 1918, p. 49—56; Ubaghs, 1967, p. 493) has a central umbo and stellate thecal plates. Other genera of eocrinoids from North America, such as *Marjumicystis* Ubaghs et Robison, *Eustypocystis* Sprinkle, *Nolichuckia* Sprinkle and *Trachelocrinus* Sprinkle, have polygonal thecal plates, without sutural pores and epispires; among them, a genus (*Marjumicystis*) is devoid of stem whereas another genus (*Nalichuckia*). possesses a well-developed holdfast. Obviously, the eocrinoids of Lower—Middle Cambrian from North America are abundant not only in number, but also in genera and species; they differ from the eocrinoids of Taijiang in shape and morphological features. Among the Middle Cambrian eocrinoids from Bohemia, such as *Akadocrinus* Prokop, *Acanthocytites* Barrande, *Lichenoides* Barrande, the first two genera are characterized by the unbranched biserial brachioles, and the thecae with irregularly arranged polygonal plates and oval—shaped sutural pores. Besides, in *Akadocrinus*, the stem exhibits different structures from that of *Gogia* and Sinoeocrinidae; its length is equal to 5 or 6 times the height of theca, with a holdfast at the distal end. As to *Lichenoides*, it is characterized by the absence of the stem, the less thecal plates, and the more developed epispires and sutural pores. In morphological features, the eocrinoids of Bohemia also differ from those of Taijiang.

The eocrinoids of Taijiang are well-preserved in silty mudstone and mudstone of the middle part of the Kaili Formation in Guizhou. Since nearly all specimens are preserved in lateral view, it is difficult to describe features of oral surface which is generally poorly preserved. There are mainly two horizons of eocrinoids in the Taijiang section. The lower horizon contains *Sinoeocrinus logus*, *S. lepidus*, *S. minus* and *Curtoeocrinus guizhouensis*, in which the bodies are small in size; with less thecal plates (generally numbering 32—40) and less brachioles, (numbering 4—6 in most species). The upper horizon

contains *Sinoeocrinus lui*, *S. curtobrachiolus*, *Paragogia globosa* and *Curtoeocrinus guizhouensis*, in which the bodies are relatively bigger in size; and the thecal plates are more in number, with 40—50 of them in most species. They display an evolutionary tendency from lower horizon to upper horizon toward an increase in body size, and an increase in the number of thecal plates and brachioles. The fossil eocrinoids from Taijiang are associated with abundant trilobites such as *Oryctocephalus*, *Pagetia*, *Peronopsis*, *Kaotaia*, *Olenoides*, brachiopods, etc. It is noticeable that in two eocrinoids the bodies are connected with the stem (pl. Ⅲ, fig. 3; text-fig. 6.); their nature and origin await further study. There are 1—5 pores in the central part of stem plates and thecal plates on some specimens of *Sinoeocrinus longus*. The possession of thecal pores is an important feature of cystoids.

The fossil eocrinoids from Taijiang constitute a prominent part of the Kaili Fauna. The discovery of Cambrian eocrinoids from Taijiang may be of essential significance in the study of evolution and classification of Eocrinoidea.

SYSTEMATIC PALAEONTOLOGY

Subphylum Crinozoa Matsumoto, 1929

Class Eocrinoidea Jaekel, 1918

Sinoeocrinidae fam. nov.

Type genus *Sinoeocrinus* gen. nov.

Diagnosis Body small to medium in size. Thecal plates polygonal, regularly arranged, numbering 32—50. Sutural pores small. Epispires generally developed. Brachioles less in number. Stem long; stem plates regularly arranged.

Discussion The new family differs from Eocrinidae Jaekel (Ubaghs, 1967, p. 478) in the smaller body, less thecal plates, smaller sutural pores, more regularly arranged thecal plates and stem plates.

Age Middle Cambrian.

Sinoeocrinus gen. nov.

Type species *Sinoeocrinus lui* gen. et sp. nov.

Diagnosis Body small to medium in size. Theca apparently pyriform, elliptical or subspherical in outline. Thecal plates polygonal in shape, regularly arranged, numbering 32—50, with basal plates; infralateral plates; lateral plates; and radial plates which may be designated from aboral surface to summit. Sutural pores small in size and less in number, usually overlapping with epispires, forming the sutural pores of the *Sinoeocrinus* type. Epispires generally developed. Stem long; stem plates regularly arranged.

Discussion The new genus is similar to *Gogia* Walcott (Walcott, 1917, p. 27; Robison, 1965, p. 358—362; Ubaghs, 1967, p. 478; Sprinkle, 1976, p. 62—65; Paul and Smith, 1984, p. 457—460) in the shape of theca and length of brachioles, but the latter has more irregularly arranged thecal plates; well-developed sutural pores; much longer and more brachioles; shorter and thick stem and

much more irregularly arranged stem plates. The North American genus *Eustypocystis* Sprinkle (Ubaghs and Robison, 1985, p. 21) possessed of stem and polygonal thecal plates, is somewhat similar to the new genus, but differs in the irregularly arranged thecal plates, and the absence of sutural pores and epispires.

Occurrence Early Middle Cambrian; Guizhou, China.

Sinoeocrinus lui gen. et sp. nov.

(Pl. Ⅰ, fig. 1; pl. Ⅱ, fig. 1; text-fig. 2)

Material 15 complete individual specimens.

Description Body medium in size, usually 22.0—35.0 mm in length. Holotype 26.5mm in length. Theca elliptical, ovoid, 7.5mm in length. Thecal plates ranging from 40 to 50 in number, polygonal, usually largest in size in central part of theca, (Holotype) 2.0mm in length, regularly arranged in successive circlets, as a rule, in alternation, with basal plates(4); infralateral plates (5); lateral plates (5); and radial plates(6) which may be designated from aboral surface to summit. Sutural pores small, located at the top of the angle of hexagonal thecal plates, overlapping with epispires in position, but absent in sutures. Brachioles numbering 4—12, straight and long, with the longest one observed (Holotype) 11.0mm, which is obviously longer than the theca. Brachiole plates polygonal, regularly arranged, unbranched. Stem long, relativcly thicker at proximal end and gradually becoming thinner towards distal end with stem plates regularly arranged, polygonal, relatively bigger at the proximal end but smaller at the distal end.

Locality and horizon Gedong, Taijiang County, eastern Guizhou, middle part of Kaili Formation (Early—Middle Cambrian).

Sinoeocrinus curtobrachiolus gen. et sp. nov.

(Pl. Ⅱ, figs. 3, 4; text-fig. 3)

Material 5 complete individual specimens.

Comparison The new species is quite similar to the type species, but differs from the latter in the smaller body, the less thecal plates, the relatively shorter and curved brachioles; and the shorter and thicker stem.

Locality and horizon Same as the preceding species.

Sinoeocrinus lepidus gen. et sp. nov.

(Pl. Ⅳ, figs. 3, 6, 8; text-fig. 4)

Material 12 complete individual specimens.

Description Body smaller in size, 17.2mm in length in holotype. Theca elliptical or subspherical, widest in the middle-upper part, 4.5mm in width and 6.5mm in length in holotype. Thecal plates polygonal, regularly arranged, numbering 36—40; with basal plates(4), infralateral plates (5—6), lateral plates (5—6), and radial plates (8—10) which may be designated from aboral surface to summit. Sutural pores and epispires belong to *Sinoeocrinus* type. Brachioles 4 in number, usually ex-

tending in two directions. Stem thicker and shorter, composed of 4 rows of stem plates.

Comparison The new species differs from *Sinoeocrinus lui* and *S. curtobrachiolus* in having less thecal plates, less brachioles, shorter stem and much less stem plates.

Locality and horizon Same as the preceding species.

Sinoeocrinus longus gen. et sp. nov.

(Pl. Ⅳ, figs. 2, 4, 7; text-fig. 5)

Material 10 complete individual specimens.

Description Body smaller in size, usually 14.0—18.0mm (holotype 15.2mm) in length. Theca elliptical or pyriform, widest in the upper part; holotype 4.5mm in width, 7.0mm in length. Thecal plates bigger, polygonal (including hexagonal ones in the middle part of theca), regularly arranged, with basal plates(5), infralateral plates(5), lateral plates(4), radial plates(5), and anal plates, which may be designated from aboral surface to summit. Sutural pores and epispires less in number. Brachioles only 4, longer. Stem long, exceeding thecal length, composed of 4 rows of small plates. Some stem plates with 1—5 tiny pores.

Comparison The new species is similar to the type species in the shape of body, thecal plates and stem, but differs in having smaller body, less thecal plates, much less sutural pores, less brachioles, less stem plates and 1—5 tiny pores in some stem plates. It is different from the North American Middle Cambrian genus *Eustypocystis* Sprinkle (Ubaghs and Robison, 1985, p. 21) in having bigger regularly arranged thecal plates, and longer stem.

Locality and horizon Same as the preceding species.

Sinoeocrinus minus gen. et sp. nov.

(Pl. Ⅱ, figs. 1—5.; text-fig. 6)

Material 7 complete individual specimens.

Description Body small in size; holotype (left body) 7.3mm in length, which is equal to the width of theca. Thecal plates polygonal (mainly hexagonal), numbering 32—38, regularly arranged, with basal plates (4—5), lateral plates (6), radial plates (6) and anal plates which may be designated from aboral surface to summit. Sutural pores and epispires feebly developed. Brachioles 4—5 in number, composed of regularly arranged polygonal brachiolar plates. Stem conical, composed of some polygonal plates.

Comparison The new species is quite similar to *Sinoeocrinus longus* in the morphological features of theca, the developmental degree of sutural pores and epispires and the number of brachioles, but the latter has more thecal plates, longer stem, and much less brachioles. It differs from *Eustypocystis* Sprinkle (Ubaghs and Robison, 1985, p. 21.) in having bigger and regularly arranged thecal plates.

Locality and horizon Same as the preceding species.

Family Eocrinidae Jaekel, 1918

Paragogia gen. nov.

Type species *Paragogia globosa* gen. et sp. nov.

Diagnosis Body bigger in size, usually over 45mm in length. Theca subspheroidal. Thecal plates regularly arranged. Sutural pores and epispires developed. Brachioles more than 8 in number, long and curved. Stem long, and curved; stem plates regularly arranged.

Discussion The new genus is similar to *Gogia* Walcott (Walcott, 1917, p. 27; Robison, 1965, p. 358—362; Ubaghs, 1967, p. 478; Sprinkle, 1976, p. 62—68; Paul and Smith, 1984, p. 457—466) in the shape of body and theca, and the morphological features of thecal plates and sutural pores, but the latter has much more irregularly arranged thecal plates, much developed sutural pores, much more and much longer brachioles, shorter and thicker stem, and much more irregularly arranged stem plates. It differs from *Sinoeocrinus* in having subspheroidal theca, more developed sutural pores and epispires, and bigger body.

Occurrence Early Middle Cambrian; Guizhou, China.

Paragogia globosa gen. et sp. nov.

(Pl. I, fig. 2; text-fig. 7)

Material 4 complete individual specimens.

Description Body bigger in size; holotype 51.6mm in length, with theca 16.0mm in length. Theca subspheroidal, 14.5mm in width. Thecal plates numbering 40—50, regularly arranged in successive circlets, with basal plates (4), infralateral plates (5), lateral plates (6), and radial plates (6) which may be designated from aboral surface to summit. Sutural pores developed, elliptical in outline. Epispires tiny, usually present in sutures between thecal plates within sutural pores, similar in morphological features to that of *Lichenoides* Barrande (Ubaghs, 1967, p. 460, fig. 295; p. 480—481, fig. 308). Brachioles long, rather curved, ranging from 8 to 12 in number. Stem long, equal to theca in length, composed of regular plates.

Locality and horizon Same as the preceding species.

Family Lichenoididae Jaekel, 1918

Curtoeocrinus gen. nov.

Type specis *Curtoeocrinus guizhouensis* gen. et sp. nov.

Diagnosis Body devoid of stem. Theca small, ovoid or elliptical, composed of big and small thecal plates, regularly arranged in three successive circlets. Sutural pores developed, elliptical, similar in morphorical features to that of *Akadocrinus* Prokop, 1962 (Ubaghs, 1967, p. 466, fig. 100-1). Brachioles developed, branched.

Discussion The new genus is quite similar to *Lichenoides* Barrande (Ubaghs, 1967, p. 460, fig. 295; p. 480—481, fig. 308) in lacking the stem, the outline of theca, and the less thecal plates regularly arranged in three successive circlets, but in the latter, the sutural plates and epispires are much

more developed; each sutural pores is prolonged into an elongated groove; the epispires are big, present in the sutures between thecal plates within long groove-shaped sutural pores; and the brachioles are much more in number, unbranched, simple or in cluster, with 2 or 3 of them on the lateral or radial plates.

Occurrence Early Middle Cambrian; Guizhou.

Curtoeocrinus guizhouensis gen. et sp. nov.

(Pl. Ⅳ, figs. 1; pl. Ⅴ, fig. 1—5; text-fig. 8)

Material 2 complete and 4 incomplete individual specimens.

Description Theca small (holotype 9.0mm in length and 6.0mm in width), ovoid in outline, composed of big and small thecal plates regularly arranged in three successive circlets; basal circlet comprising 2 big basal plates and separated ossicle; middle circlet comprising 4 big lateral plates; upper circlet comprising 5—6 big radial plates and some small plates. Sutural pores developed, circular or elliptical, similar to those of *Akadocrinus*. Aboral portion of theca shown by one specimen, consisting of an area about 1mm in width, surrounded by brachiolar plates and other small thecal plates. Brachioles developed, composed of numerous polygonal regularly arranged plates, branched, attached to brachiolar plates.

Locality and horizon Same as the preceding species.

Subphylum Homalozoa Whitehouse, 1941

Class Homoistelea Gill et Gaster, 1960

Fam. gen. et sp. indet.

(Pl. Ⅳ, fig. 5; text-fig. 9)

Material 1 complete individual specimen.

Description Body small, 11.0mm in length. Theca spheroidal. Thecal plates relatively big, polygonal, usually largest in size in central part of theca, 0.7mm in length, with marginal frame. An arm present in lateral front of the theca in lateral view, with a curved food groove in its middle part. Stele longer, composed of 4 rows of regularly polygonal plates.

Comparison The specimen is similar to *Castericystis vali* Ubaghs et Robison (1985 p. 1—17, figs. 1—12), but the latter has elliptical theca, much more thecal plates, much longer stele and much more stele plates, without marginal frame.

Locality and horizon Same as the preceding species.

图 版 说 明

标本均采自贵州台江下、中寒武统凯里组中部 *Xingrenaspis-Oryctocephalus* 带(中寒武统),存放在贵州工学院地质系。

图 版 Ⅰ

1. *Sinoeocrinus lui* gen. et sp. nov.

完整个体,萼为实体,茎、腕为内部构造,腕仅暴露 3 枝,Holotype,×6;采集号:GTB-18-2-92a,登记号:

GK1701。

图 版 Ⅱ

1. *Sinoeocrinus lui* gen. et sp. nov.

完整个体。全部为内部构造，×4；采集号：GTB-21-1-66，登记号：1702。

2. *Paragogia globosa* gen. et sp. nov.

完整个体。全部为内部构造，Holotype，×2；采集号：GTB-23-2-96a，登记号：GK1703。

3，4. *Sinoeocrinus curtobrachiolus* gen. et sp. nov.

3. 完整个体，印模，×5；采集号：GTB-18-2-114b，登记号：G1704。4. 完整个体，萼为实体，腕、茎为内部构造，Hoiotype，×5；采集号：GTB-18-2-112a，登记号：GK1705。

图 版 Ⅲ

1—5. *Sinoeocrinus minus* gen. et sp. nov.

1. GTB-13-1-190 部分萼板电子扫描放大，未见缝孔，×150；采集号：GTB-13-1-190，登记号：GK1706。2. 不完整个体，×10；采集号：GTB-13-1-190，登记号：GK1706。3. 2 个个体完整并以根相连的标本，实体。Holotype，×11；采集号：GTB-24-2-60a，登记号：GK1707。4. 不完整个体，内部构造。缺茎，但在萼下方有茎的外模，×10；采集号：GTB-23-2-73，登记号：GK1708。5. 不完整个体，印模，缺茎；×10；采集号：GTB-18-2-115，登记号：GK1709。

图 版 Ⅳ

1. *Curtoeocrinus guizhouensis* gen. et sp. nov.

萼板，×10；采集号：GTB-20-3-15，登记号：GK1710。

2，4，7. *Sinoeocrinus longus* gen. et sp. nov.

2. 完整个体，内部构造，×4；采集号：GTB-13-1-14，登记号 1711。4. 完整个体，内部构造，Holotype，×3；采集号：GTB-13-1-1a，登记号：GK1712。7. 完整个体，印模，×3；采集号：GTB-13-1-1b，登记号：GK1713。

3，6，8. *Sinoeocrinus lepidus* gen. et sp. nov.

3. 完整个体，内部构造；×3；采集号；GTB-22-4-42，登记号：GK1714。6. 完整个体，内部构造，Holotype，×5；采集号：GTB-13-2-3a，登记号：GK1715。8. 完整个体，印模，有腕足动物共生，×8；采集号：GTB-13-1-80，登记号：GK1716。

5. Homalozoa fam. gen. et sp. indet.

完整个体，印模，×8；采集号：GTB-24-1-100，登记号：GK1717。

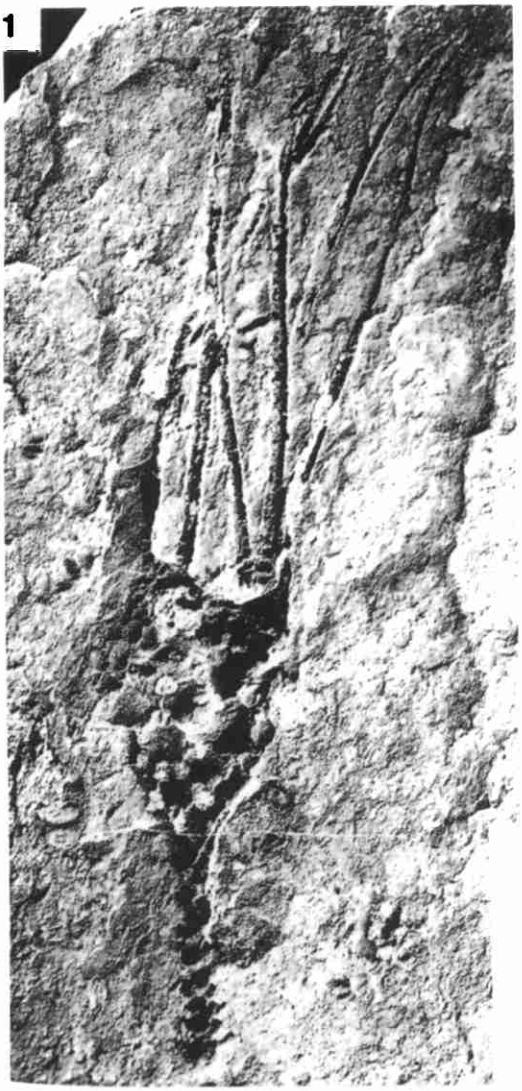
图 版 Ⅴ

1.—5. *Curtoeocrinus guizhouensis* gen. et sp. nov.

1. 完整个体，内部构造，×5；采集号：GTB-13-1-194，登记号：GK1718。2. 不完整个体，印模，腕及萼项的一部分，×5；采集号：GTB-19-4-156，登记号：GK1719。3. 不完整个体，正体，腕及萼顶的一部分；×5；采集号：GTB-19-4-156a，登记号：GK1720。4. 完整个体，实体，Holotype，×5；采集号：GTB-13-1-159，登记号：GK1721。6. 萼板，×10；采集号：GTB-20-1-15，登记号：GK1722。

1

1



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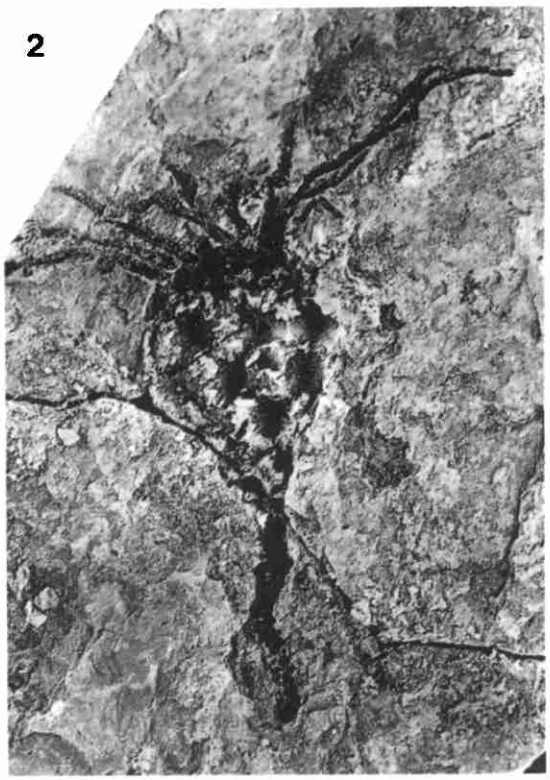

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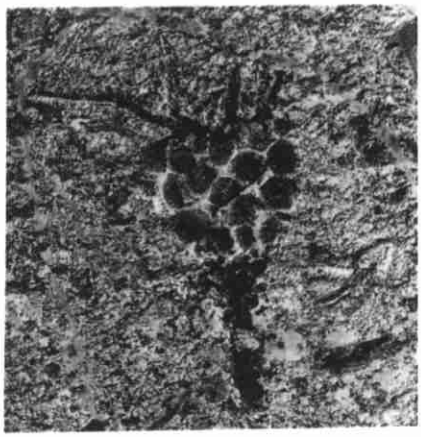

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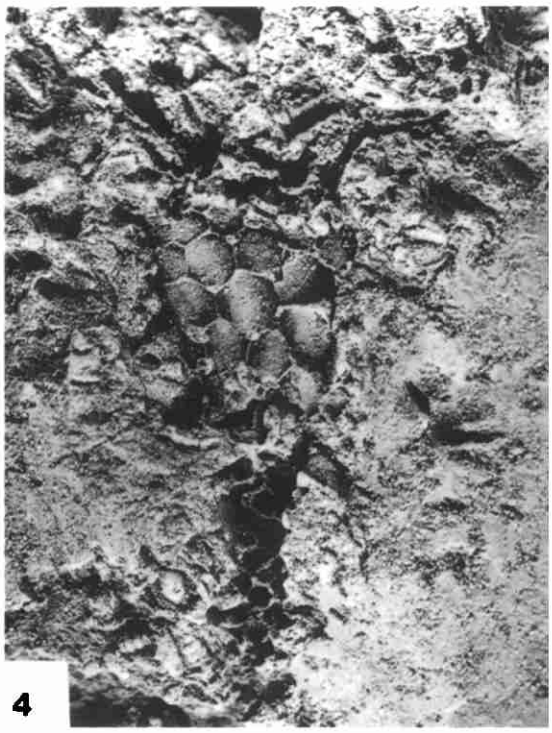
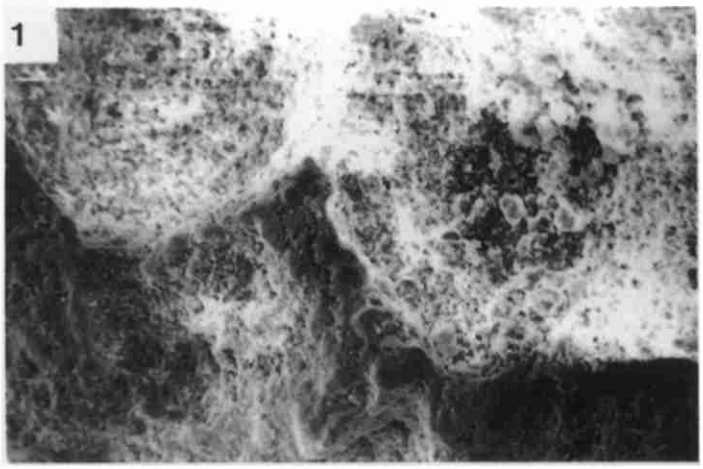
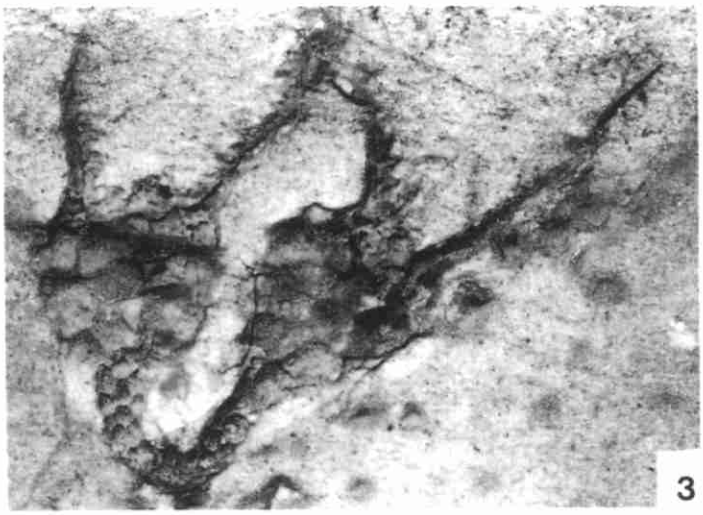



1


2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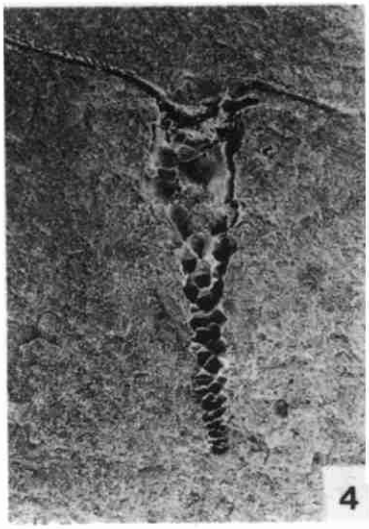
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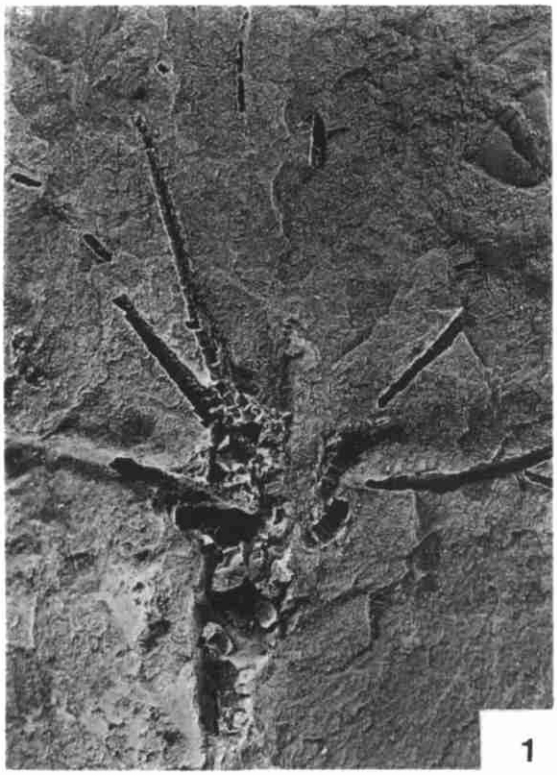
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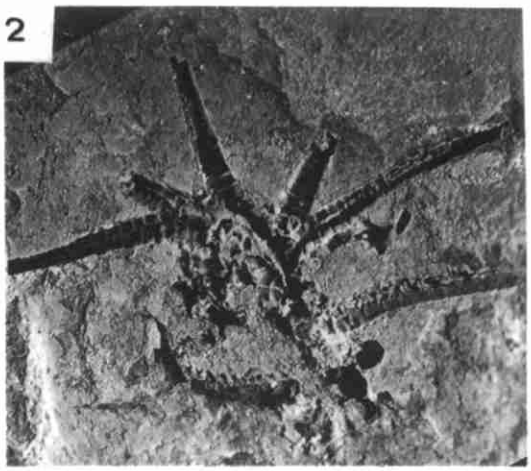
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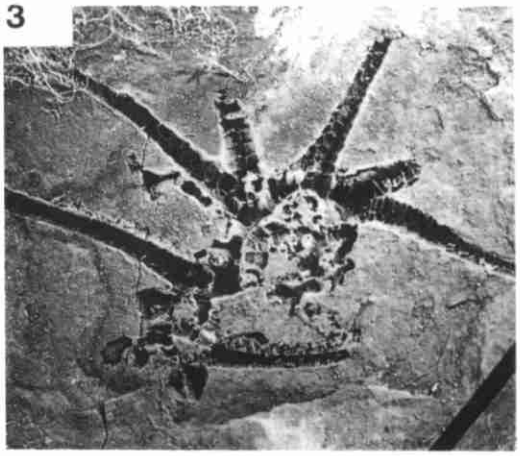
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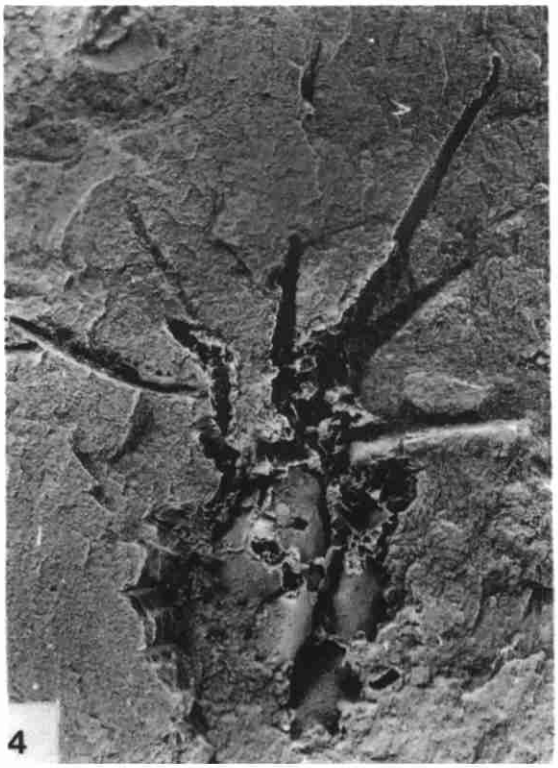
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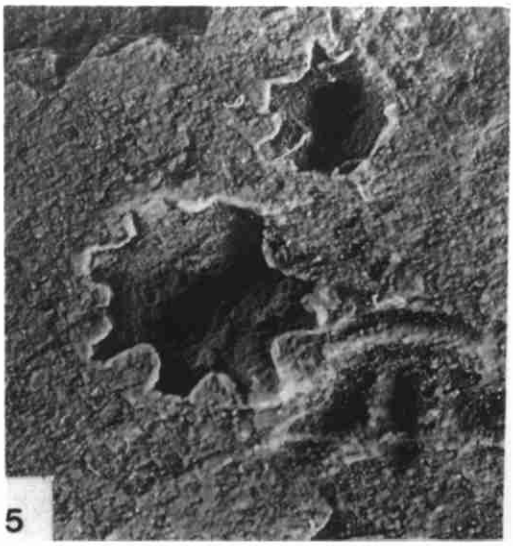
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