



Some major fossil taxa

- **Fusulinids (protozoan)**
- **Corals (Coelenterata)**
- **Molluscs (Mollusca)**
- **Trilobites (Arthropoda)**
- **Brachiopods (Brachiopoda)**
- **Graptolites (Hemichordata)**
- **Vertebrates (Chordata)**
- **Plants (Plantae)**

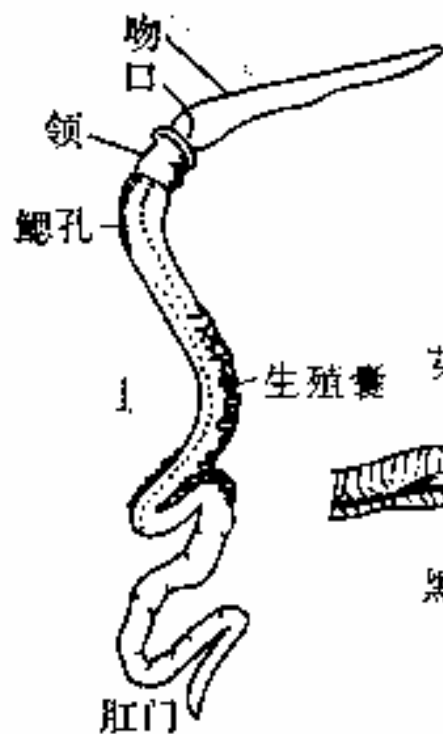


中国地质大学

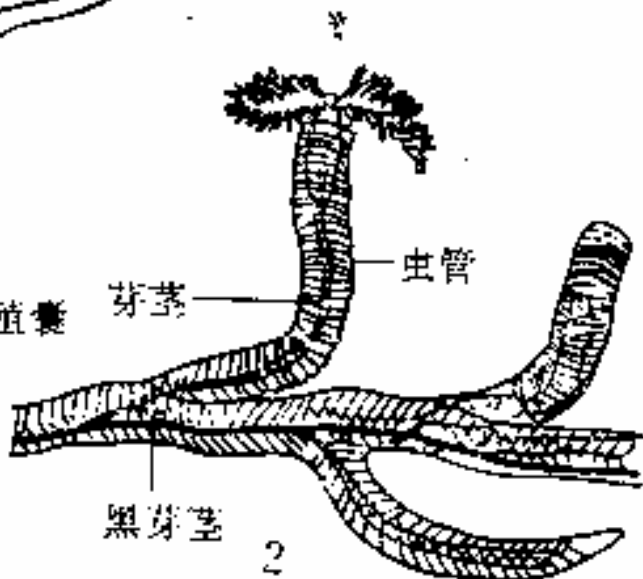
China University of Geosciences



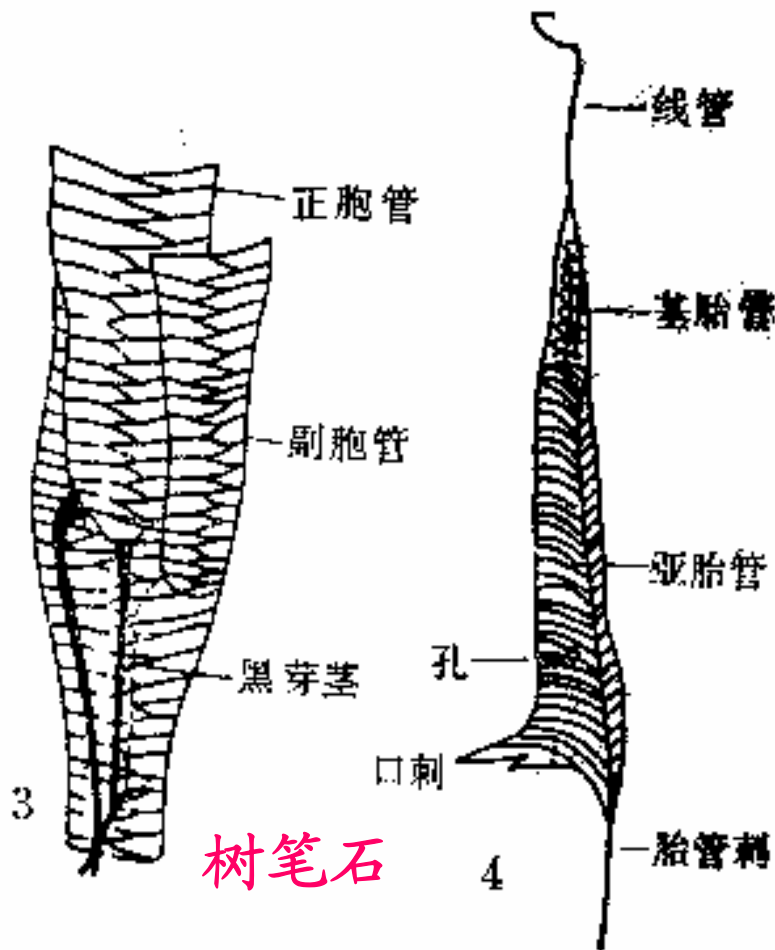
半索动物门(Hemichordata)



长舌虫



杆壁虫



树笔石



半索动物门(Hemichordata)

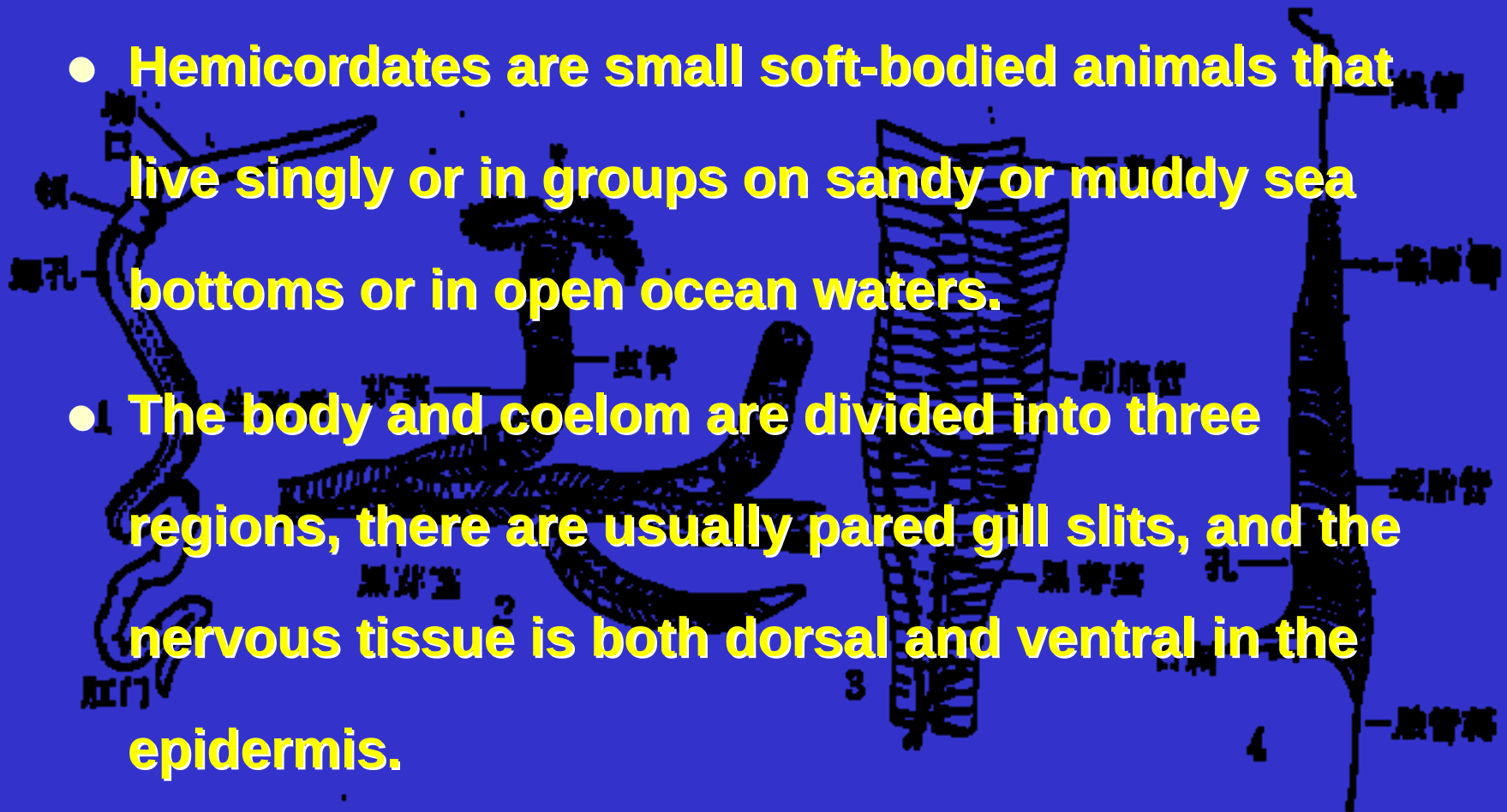
- 特有口索stomochord: 口腔背面向前伸出的一条短盲管。有人认为口索是最初出现的脊索notochord, 因而曾作为一个亚门归属于脊索动物门。
- 具背神经索dorsal nerve cord: 背神经管的雏形
- 消化管前端有鳃裂gill slit: 呼吸器官



Hemichordata

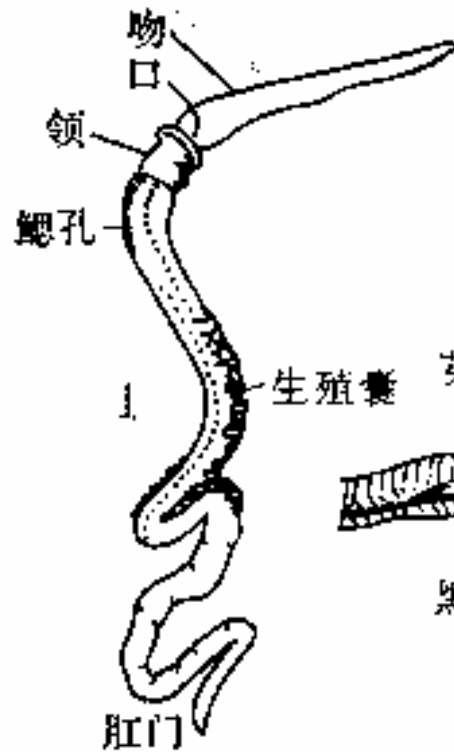
- Hemichordates are small soft-bodied animals that live singly or in groups on sandy or muddy sea bottoms or in open ocean waters.

- The body and coelom are divided into three regions, there are usually paired gill slits, and the nervous tissue is both dorsal and ventral in the epidermis.

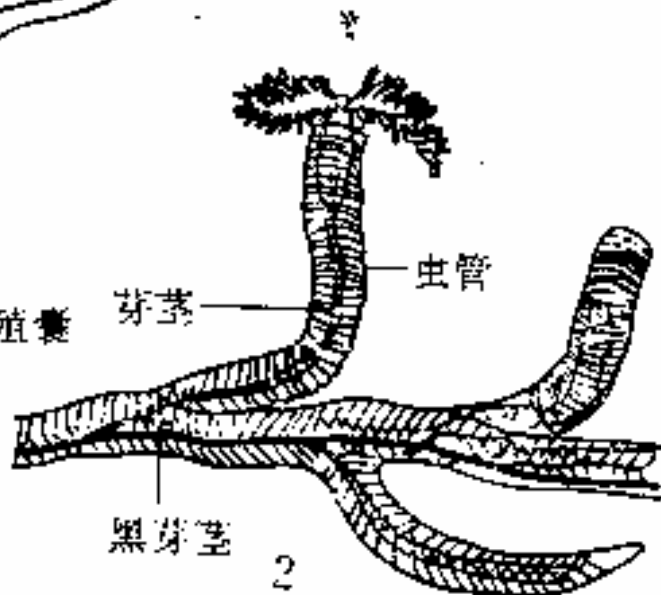




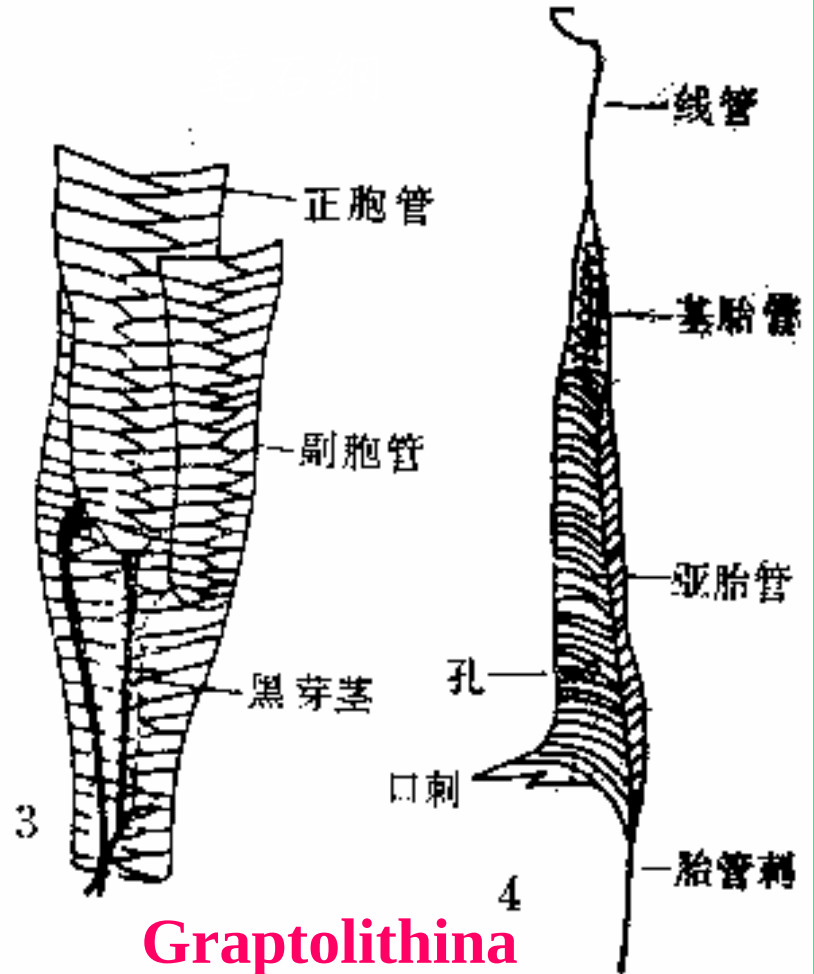
classification



Enteropneusta



Pterobranchia



Graptolithina



笔石纲(Graptolithina)

- In the dark, shaly sequences of the Lower Paleozoic, you stand a reasonably good chance of finding graptolites (笔石).
- Their name could be translated as “written on stone”, reflecting their appearance of being inscribed on the bedding plane.
- Most of the graptolites you will see look like one or more hacksaw blades, with rather little morphological detail.



笔石纲(Graptolithina)

- 海生, 个体小, 群体动物
- 几丁质硬体, 经石化升馏作用而保存为碳质薄膜化石
- 绝灭生物, 中寒武世 - 早石炭世。奥陶纪 - 志留纪标准化石
- 主要有两大类
 - 树形笔石类dendroids: 树枝状, 底栖固着
 - 正笔石类graptoloids: 列式, 漂浮生活----指相化石

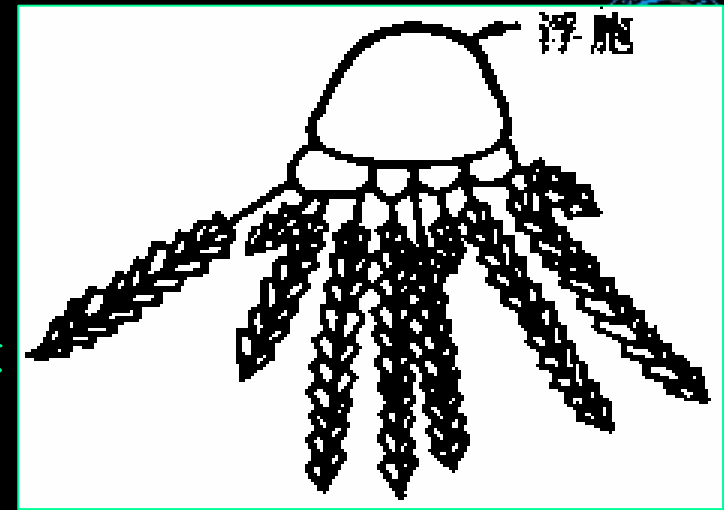


中国地质大学

China University of Geosciences

graptolites

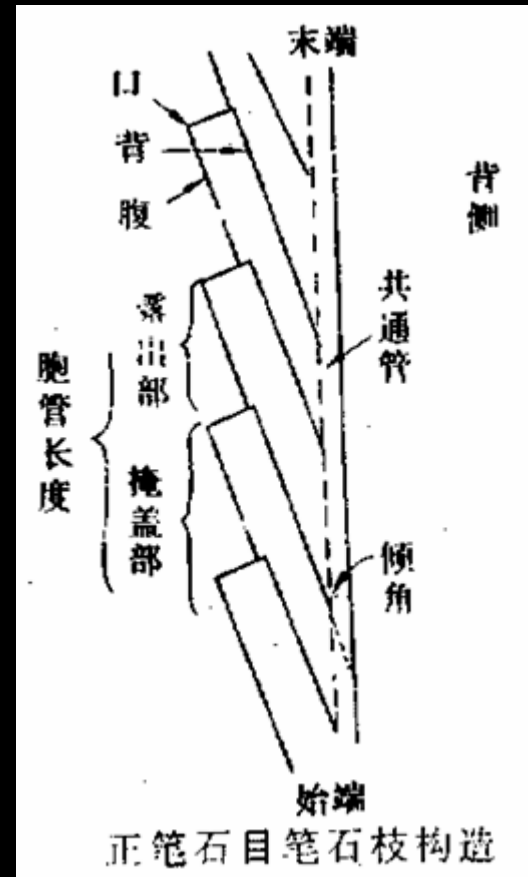
- The skeleton of a graptolite is known as the **rhabdosome** 笔石体
- This may often be divisible into separate stick-like units called **stipes** 笔石枝
- Each stipe is basically a hollow tube along which many small cups called **thecae** 胞管 are connected
- It is these which give rise to the serrated effect along the edges of specimens, and in each theca there once lived a separate graptolite animal, referred to as the **zooid** 笔石虫





graptolites

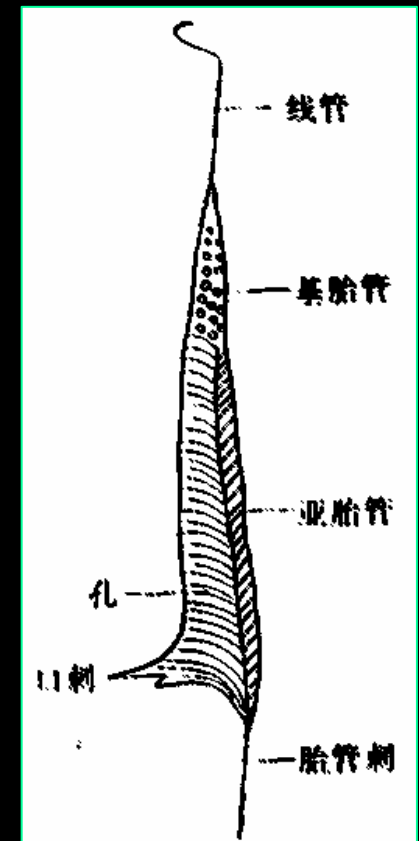
- A complete graptolite consisted of many individuals linked together by a **common canal** 共通沟; hence they were colonial animal





graptolites

- Growth of a graptolite colony proceeded from a primary individual which lived in the **sicula** 胎管, a conical cup which may, at its apex, be seen to bear a long thread or **nema** 线管
- These basic features are common to both orders of graptolite, but their more detailed morphology must be treated separately





dendroids

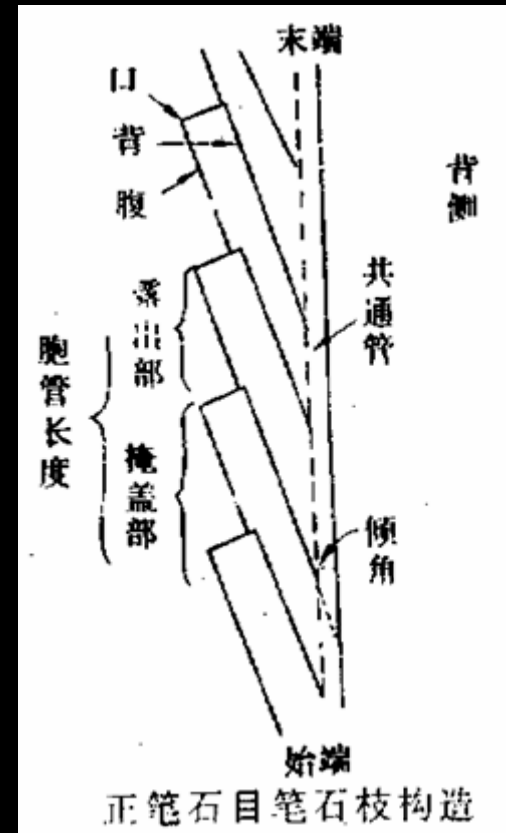
- From the sricula, a large cup called a **stolotheca** 茎胞 grew out
- When this zooid budded, it gave rise to two new individuals. One was a large **autotheca** 正胞管 and the other a smaller **bitheca** 副胞管
- Autothecae and bithecae were linked by the stolotheca





graptoloids

- Graptoloids are made up of between one and four main stipes
- All the thecae on any one rhabdosome were of similar shape, and their microstructural details were different from dendroids
- Graptoloids had no preservable stolon, though there was probably some similar structure passing down the common canal

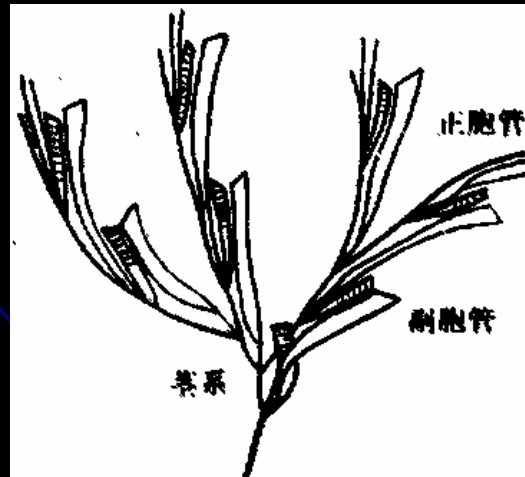
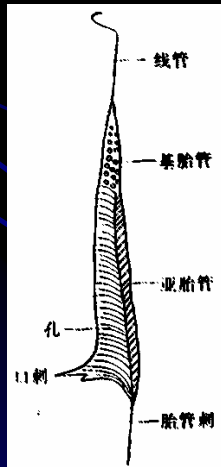




graptolites

- 硬体构造skeleton

胎管 **sicula** → 胞管 **theca** → 笔石枝 **stipe** → 笔石体 **rhabdosome** → 笔石簇 **synrhabdosome**
(或笔石丛 **corrhabdosome**)

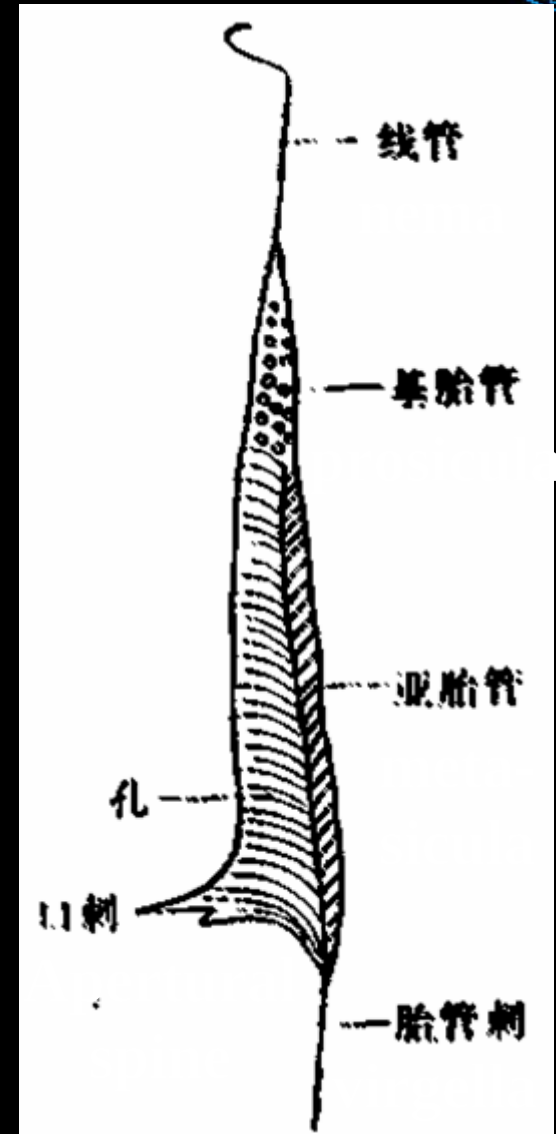




graptolites

胎管 **sicula**

- 胎管 **sicula**: 第一个个体分泌的圆锥形外壳，开口朝下，尖端朝上
- 线管 **nema**: 胎管上方伸出的一条细线状小管
- 中轴 **virgula**: 由线管硬化而成





graptolites

theca胞管

第一个胞管由胎管侧面的一个小孔出芽生出。有三种胞管：
正胞autotheca、副胞bitheca、茎胞stolotheca（茎系）

- 仅树形笔石类dendroids有这三种胞管，较大的正胞管和较小的副胞管均向外开口，茎胞连接成枝
- 正笔石类graptoloids仅有正胞，但其胞管形态复杂多样





graptolites

正笔石类的十种胞管类型 variation in thecal morphology

1. 均分笔石式 **dichograptid type**: 胞管直管状
2. 单笔石式 **monograptid type**: 胞管外弯呈钩状
3. 卷笔石式 **streptograptid type**: 胞管外卷呈球状
4. 半耙笔石式 **demirastritid type**: 胞管向外扩展, 大部分孤立, 呈三角形
5. 耙笔石式 **rastritid type**: 呈全孤立耙形



正笔石目胞管的不同类型



graptolites

正笔石类的十种胞管类型 variation in thecal morphology



6. 纤笔石式leptograptid type: 胞管腹部呈波状曲折

7. 栅笔石式climacograptid type: 胞管强烈内折，具方形口
穴

8. 叉笔石式dicellograptid type: 胞管口部向内转曲

9. 瘤笔石式tylograptid type: 形成背褶，口部内转，腹褶弱

10. 中国笔石式sinograptid type: 形成背褶及柱状腹褶

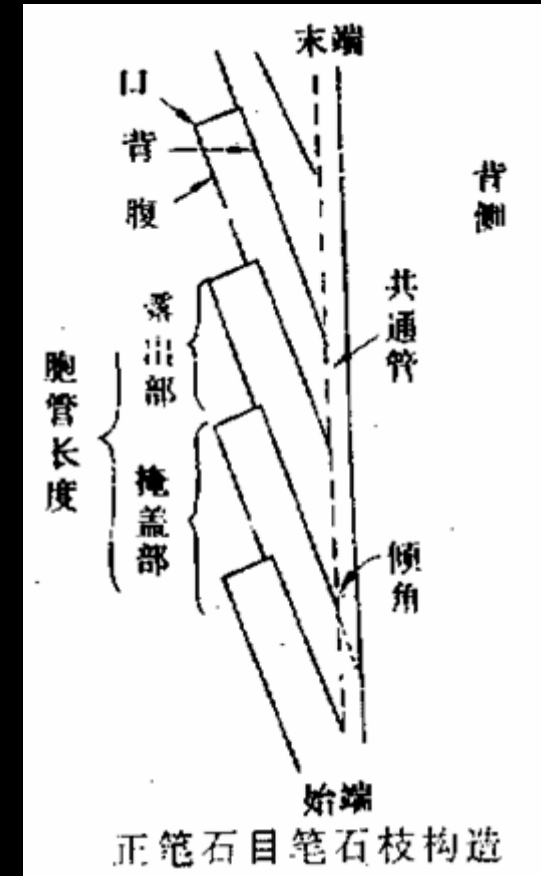


graptolites

stipe 笔石枝

成列的胞管构成笔石枝

- 始端：近胎管的一端
- 末端：胞管增长的一端
- 共通管（沟）：在笔石枝背部连通各个胞管
- 腹侧：胞管所在的一侧
- 背侧：靠近共通管（沟）的一侧
- 每个胞管靠近共通管一边为背，另一侧为腹





graptolites

growth of stipes

以胎管尖端向上，口部向下为基准，可以分为六种类型：

下垂式pendent

下斜式declined

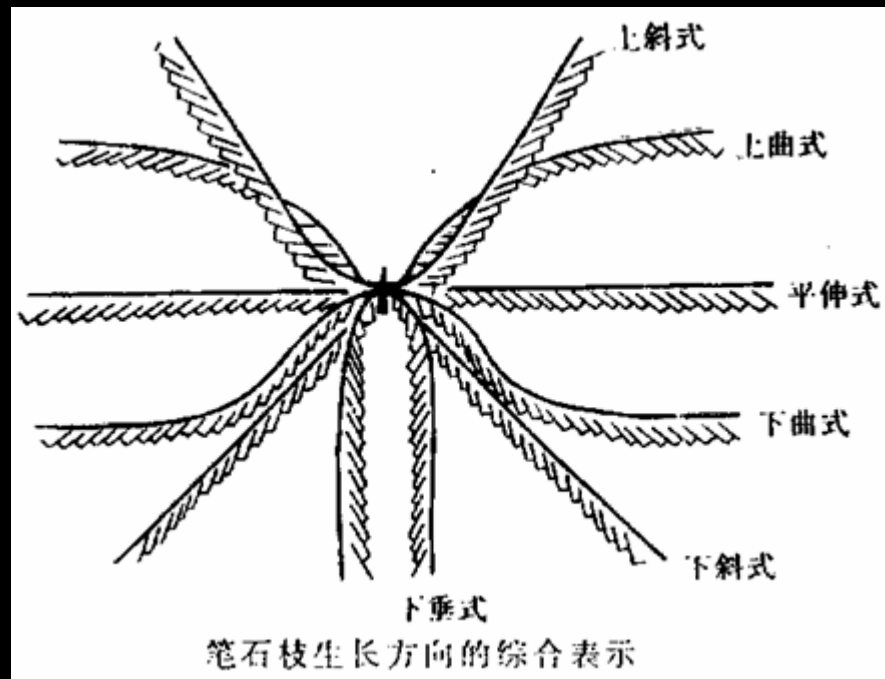
下曲式deflexed

平伸式

horizontal

上斜式reclined

上曲式reflexed



graptolites

笔石枝上胞管的排列方式

单列式uniserial

双列式biserial

四列式quadriserial

个别还有三列式triserial



graptolites

rhabdosome and synrhabdosome

- **rhabdosome**笔石体：由一枝以上的笔石枝构成
 - **graptoloids**正笔石类的笔石体有一个或多个笔石枝
 - **dendroids**树形笔石类的笔石体由多个复杂分支的笔石枝构成

- **synrhabdosome**笔石簇：

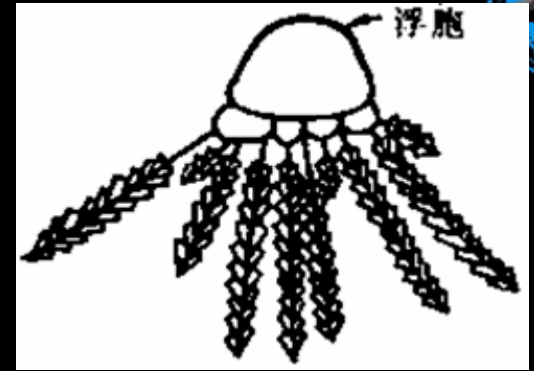
由多个笔石体聚在一个浮胞上，以中轴相连形成的综合体





graptolites

ecology



- **生活方式:** 树形笔石类大部分为固着生活，其它各类笔石大都是浮游生活
- **生活环境:** 滨海、陆棚边缘到陆棚斜坡等海域
- **保存岩性:** 可以保存在各类沉积岩中，但以页岩为主，尤其黑色页岩

graptolites

geological history

- 始现于中寒武世
- 寒武纪以树形笔石类为主
- 奥陶纪正笔石类极盛
- 志留纪开始衰退
- 早泥盆世末正笔石类绝灭
- 树形笔石目的少数分子延续到早石炭世绝灭（笔石完全绝灭）