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贵州台江早寒武世台江生物群*

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提要 台江八郎下、中寒武统界线之下的灰绿色粉砂质泥岩中存在一个布尔吉斯页岩型生物群,即台江生物群。现已发现的台江生物群含 8 个门类 40 多个属的生物化石。其中三叶虫特多,其次为刺胞动物、"蠕虫动物"、海绵动物等。非三叶虫节肢动物、软躯体化石很少。这一生物群形成于浅海内陆棚环境。

关键词 台江生物群 早寒武世 贵州 台江

1 前言

随着早期后生生物知识的普及与地质、古生物学家寻找早期后生生物经验的积累,早期后生生物不断地被发现:诸如华北地区前震旦系 17—18 亿年的长城系中陆续发现单细胞真核浮游生物及碳质叶状宏观藻类(朱士兴等,1999)、三峡震旦系陡山陀组中的庙河生物群(陈孟莪等,1994)、化石保存很好的陕西晚震旦世末期的高家山生物群等(张录易,1986)。素有古生物王国之称的贵州,后生生物的研究也有突破性进展。贵州震旦系陡山陀组中瓮安生物群中的藻类,达到了现代藻类形态学复杂性程度相当的水平(Xiao *et al*., 1998),而且可能存在海绵等动物化石(Li *et al*., 1998);近期贵州中寒武早期凯里生物群研究所取得的突破性进展,使凯里生物群的组成产生重大变化,并使其成为继布尔吉斯页岩生物群、澄江生物群以后,发现的第三大寒武纪特异埋藏生物群(赵元龙等,1999)。新的发现还有台江早寒武世台江生物群及遵义早寒武世牛蹄塘组生物群(赵元龙等,1999)。

台江生物群是在凯里生物群发现以后,经过长期的下、中寒武统界线及凯里生物群研究,不断采集化石,积累资料,于界线之下的粉砂质泥岩中发现其存在的(赵元龙等,1998)(插图 1)。

2 台江生物群的组成

台江生物群至今尚未系统采集化石和研究,但已经发现的化石含有 8 个门类 40 多属(亚属),包括①宏观藻类,②疑源类,③多孔动物门,④刺胞动物门,⑤"蠕形动物",⑥软舌螺

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化石，⑦软体动物，⑧腕足动物，⑨节肢动物，⑩棘皮动物，⑪其它动物。其中动物化石30多属。

1）宏观藻类　宏观藻类比较少，主要有 *Wavilaminaria*，*Fractikeltia*，*Bosworthia* 等属。

2）疑源类　疑源类比较丰富，有8个形态属：*Micrhystridium*，*Leiosphaeridia*，*Cymatiosphaera*，*Synsphaeridium*，*Granomarginata*，*Pterospermella*，*Leiofusa*，*Cristallinium* 等。其种的组合特征显示早寒武世末期面貌（尹磊明、杨瑞东，1999）。

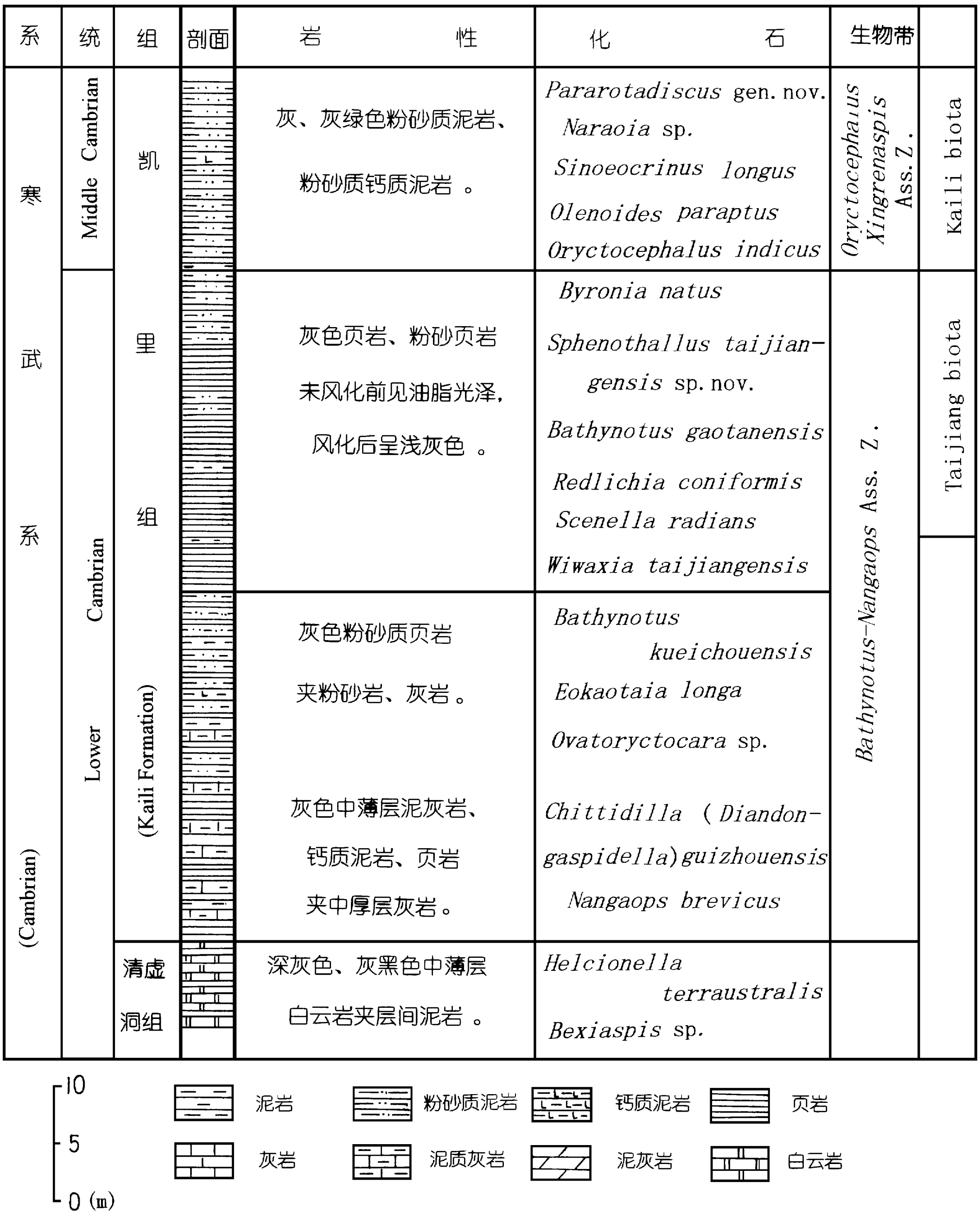

插图1　贵州台江八郎凯里组下部柱状图

The columnar section of the lower part of the Kaili Formation at Balang, Taijiang, Guizhou

3) **多孔动物** 包括开腔骨类在内共有 3 属：*Protospongia*, *Hazelia*(图版Ⅱ,图 3)及 *Chancelloria*,另有一个新类型(图版Ⅱ,图 10)。*Protospongia* 标本较多,*Chancelloria* 常以分散的骨针出现(图版Ⅱ,图 5)。

4) **刺胞动物门** 共有 4 属, 包括 *Scenella*(图版Ⅰ, 图 2; 图版Ⅱ, 图 7), *Byronia*, *Sphenothallus*, *Cambrovitus*。*Sphenothallus* 标本曾作为非钙藻类的未定属、种来描述(毛家仁等,1994,图版Ⅱ,图 6)。实际上它是一类呈枝状的磷质虫管,最新的研究将其归入 *Sphenothallus* Hall,并成为该属最早出现的种(图版Ⅰ,图 1,3;图版Ⅱ,图 8)。*Byronia* 是具有横纹装饰的磷质虫管化石,这种磷质虫管化石过去曾在湘西的同层位地层中发现,被命名为小蠕虫(*Scolecillus* Liu, 1982),实际上它是 *Byronia* 的晚出异名。*Byronia* 在台江生物群中数量比较多(图版Ⅰ,图 4,5)。

5) **"蠕形动物"** 尚未深入研究,均为短管状或管状化石。短管状类为内核形态,分为 4 节,具纵纹(图版Ⅱ,图 2);另一类也为短管状,为印模化石,有头尾之分,不分节,体外有横纹,和螠门中的 *Echiurus* 极为相似,可能为螠门中的新属种(图版Ⅱ,图 1)。

6) **软舌螺类** 包括 *Hyolithes*? 和 *Haplophrentis*?。

7) **软体动物** 主要为单板类,包括 *Coreospira* 及 *Helcionella*(毛家仁等,1993)。

8) **腕足动物** 主要为 3 属,包括 *Kutorgina*, *Nisusia*, *Linnarssonia*。除 *Nisusia* 外,其他 2 属均属无铰纲(黄友庄等,1994)。

9) **节肢动物** 主要为三叶虫,超过 16 属,主要有 *Redlichia*(图版Ⅱ,图 9),*Bathynotus*(图版Ⅰ,图 6),*Protoryctocephalus*, *Oryctocephalites*, *Oryctocephalops* (*Eoryctocephalops*) subgen nov., *Nangaops*, *Kunmingaspis*, *Chittidilla* (*Diandongaspidella*), *Burlingia* 等(赵元龙等,1990;袁金良等,1997;郭庆军等,1998)。有一非三叶虫、非大型双瓣壳节肢动物化石标本,头、尾难以区别,无中轴、肋部之分,横沟呈交错排列,是节肢动物中的新类型化石(图版Ⅱ,图 6)。

10) **棘皮动物** 仅见孤立的萼板,未见完整的个体,从萼板形态分析,很可能是始海百合的 *Sinoeocrinus*(中国始海百合)。

11) **其他动物化石** *Wiwaxia* 是主要代表,呈孤立骨片保存(图版Ⅱ,图 4)。与其上凯里生物群中的 *Wiwaxia*(赵元龙等,1994)存在着紧密的演化关系。此外,还有一些未知的虫管及其他化石。

3 台江生物群的特征

台江生物群含大量的三叶虫,占整个生物群属总数的 50%左右,其次为刺胞动物、再次为腕足动物、海绵动物,均为 3 属。其中刺胞动物中虫管化石比较多,除了 *Byronia*, *Sphenothallus*, *Cambrovitus* 外,还有一些口部较宽也呈锥形的虫管化石尚未研究。*Scenella* 和 *Wiwaxia* 是台江生物群的重要成员,前者被认为是刺胞动物(毛家仁等,1994),全球均有分布。*Wiwaxia* 为稀少化石,产地很少,我国仅台江一处。与其上面的凯里生物群相比,两个生物群均有大量三叶虫。主要差别是台江生物群未见水母状化石及完整的棘皮动物化石;藻类和软躯体化石很少。台江生物群是一个非典型的布尔吉斯页岩型生物群。

台江生物群含有 *Bathynotus*, *Redlichia* 和 *Protoryctocephalus* 等三叶虫,其时代为早寒武世。其上限为下、中寒武统界线,该界线之上的粉砂质泥岩中出现了凯里生物群。因此,台江生物群的更准确的时代为早寒武世末期。

赋存台江生物群的岩石为灰色粉砂质泥岩,具油脂光泽,风化后呈叶片状,表面多呈浅灰色至灰白色。生物扰动极为罕见,但有时可见水平潜穴,沉积物色深,形成于内陆棚环境,海底位于氧化还原面之上。与凯里生物群形成内陆棚与外陆棚交界处较深海水相比,台江生物群形成时的海水明显较浅(张正华等,1996)。

4　研究意义及前景

台江生物群是我国继澄江生物群、凯里生物群发现以后,又一个较重要的寒武纪非典型的布尔吉斯页岩型生物群,填补了我国古生物宝库中某些空白及薄弱环节。目前全球已发现的寒武纪成规模的布尔吉斯页岩型生物群有 9—10 个(Conway Morris, 1998),早寒武世有 3 个,除我国的澄江生物群外,另 2 个为加拿大西北部的早寒武世晚期的 Mount Cap 生物群(Butterfield, 1994; Conway Morris, 1998)及格陵兰北部早寒武世中期的 Sirius Passet 生物群(Conway Morris *et al*., 1987; Peel *et al*., 1992; Conway Morris, 1998),台江为第四个,增加了全球寒武纪生物新信息,是寒武纪生物大爆发后生物多样化的又一例证,具有较重要的意义。

台江生物群上界为下、中寒武统界线,这个界线位于凯里组下部 *Bathynotus*-*Nangaops* 组合带与凯里组中上部的 *Oryctocephalus*-*Xingrenaspis* 组合带之间(Zhao *et al*.,1996;袁金良等,1997),处于 *Bathynotus*, *Redlichia* 的结束与 *Oryctocephalus indicus* 出现之间,可和美国犹他州一带下、中寒武统界线地层对比。这种观点已被部分美国学者接受,是一个潜在下、中寒武统界线层型剖面。

初步工作已证实台江生物群的存在,系统的采集及研究尚未进行,但它是一个具有研究前景的化石群。

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THE EARLY CAMBRIAN TAIJIANG BIOTA OF TAIJIANG, GUIZHOU, PRC

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Summary

Numerous specimens of a large number of fossil taxa have been collected from the lower part of the Kaili Formation (Lower Cambrian) in the Balang section near the town of Taijiang, Guizhou Province, PRC. These fossils represent a distinct community, called the Taijiang biota

(Zhao *et al*., 1998)

1 Composition of the Taijiang Biota

Intensive systematic study of the Taijiang fossil biota has resulted in the discovery of representatives of eight phyla. These are distributed among over 40 genera, more than 30 of which are animals. The components of the Taijiang biota are summarized below.

Algae: Algae are represented by rare specimens of *Wavilaminaria*, *Fractikeltia* and *Bosworthia*.

Acritarchs: Acritarchs are the most abundant microfossils in the biota and are most similar to other acritarchs from the Lower Cambrian (Yin and Yang, 1999).

Porifera: Sponges are represented by body fossil specimens of *Protospongia*, *Hazelia* (Pl. Ⅱ, fig. 3) and a new type (Pl. Ⅱ, fig. 10). Chancelloriids, which may have been closely related to sponges, also occur in the Taijiang biota, but are always preserved as isolated spicules (Pl. Ⅱ, fig. 5).

Cnidaria: This phylum is represented by *Scenella* (Pl. Ⅰ, fig. 2; Pl. Ⅱ, fig. 7), *Byronia* (Pl. Ⅰ, figs. 4, 5), *Cambrovitus* and *Sphenothallus* (Pl. Ⅰ, figs. 1, 3; Pl. Ⅱ, fig. 8). One of the specimens of *Sphenothallus* (GTB-6-2-119) (Pl. Ⅰ, fig. 3), originally described as an alga, consists of four tubes that appear to have formed a life cluster (Mao *et al*., 1994, pl. Ⅱ, fig. 6). Certain tubular fossils from the Middle Cambrian of Hunan and Guizhou provinces were identified as *Scoleciellus*, a worm (Liu, 1982). *Scoleciellus* is now considered a junior synonym of *Byronia* (Zhu *et al*., in press). Taijiang *Byronia* and *Sphenothallus* are most similar to thecate scyphozoan polyps and represent the earliest records of these two fossil genera (Zhu *et al*., in press).

"Worms": There are two types of fossils here referred to as "worms." One type consists of a short tube having four segments and longitudinal striae (Pl. Ⅱ, fig. 2); the other type has a relatively long, slender tube without segmentation but with some annular lines. The second type of "worm" is most similar to *Echiuras* (Echiuroidea; Pl. Ⅱ, fig. 1).

Hyolithids: This group is represented by *Hyolithes* and *Haplophrentis*.

Mollusca: This phylum is represented by the monoplacophorans *Coreospira* and *Helicionella* (Mao *et al*., 1993).

Brachiopods: This phyllum is represented by in articulate *Kutorgina*, *Linnarssonia* and articulate *Nisusia* (Huang *et al*., 1994).

Arthropoda: As in the Middle Cambrian Spence Shale, Wheeler Shale and Kaili biotas, arthropods are the most diverse group in the Taijiang biota, accounting for 50 percent of the total number of genera. There are more than 16 trilobite genera including *Bathynotus* (Pl. Ⅰ, fig. 6), *Oryctocephalites*, *Burlingia*, *Olenoides*, *Redlichia* (Pl. Ⅱ, fig. 9), *Nangaops* and *Chittidilla*. *Bathynotus*, *Oryctocephalites*, *Burlingia* and several other Taijiang trilobites are cosmopolitan taxa that occur in Lower Cambrian strata throughout the world.

In addition to trilobites, there is one specimen of a non-trilobite arthropod. The arthropod shows regular segmentations and lacks a distinct axis. This specimen may represent a new kind of arthropods (Pl. Ⅱ, fig. 6).

Echinodermata: Complete echinoderms have not been found, but thecal plates of *Sinoeocrinus* are present.

Other metazoa: In addition to the taxa mentioned above, the Taijiang biota also includes *Wiwaxia* (Pl. Ⅱ, fig. 4) and other poorly preserved fossils. Previously, the oldest known *Wiwaxia* were from the Mount Cap Formation (Lower Cambrian) of Canada.

2 General Features of the Taijiang Biota

As noted above, the Taijiang biota is dominated by trilobites, which account for approximately half of the total number of genera. The next most diverse phylum is the cnidarians followed by the brachiopods and then the sponges. The Taijiang biota contains several types of tubular fossils including, probably, genera other than *Byronia* and *Sphenothallus* (Zhu *et al.*, in press). There are no medusiform fossils and complete echinoderms, and relatively few soft-bodied fossils and non-trilobite arthropods. The Taijiang biota thus differs sharply from the Burgess Shale biota, in which soft-bodied fossils and non-trilobite arthropods are both diverse and abundant.

The presence of abundant *Bathynotus* (Zhao *et al.*, 1990) and *Redlichia* (Guo and Zhao, 1998) indicates that the age of the Taijiang biota is late Early Cambrian (Zhao *et al.*, 1996; Yuan *et al.*, 1997; Zhao *et al.*, 1998). Immediately above the beds containing the Taijiang biota is the Lower-Middle Cambrian boundary, so the precise age of this biota is the end of the Early Cambrian. The Taijiang biota probably is younger than the end Lower Cambrian Mount Cap biota of northwestern Canada (Butterfield, 1994). Overlying the Taijiang biota, in the Balang section, is the famous Kaili biota, the age of which is early Middle Cambrian. The Balang section thus contains two major Cambrian biotas.

The Taijiang biota occurs in a grey, thin-bedded, silty mudstone containing rare ripple marks. The grey color of the mudstone indicates that the original depositional environment was weakly oxidizing. The Taijiang biota lived on the inner part of a shallow shelf sea, in waters that generally were quiet. The original water depth was less than that of the waters which hosted the Kaili biota (Zhang *et al.*, 1996; Zhu *et al.*, 1999).

3 Significance and Prospects of the Taijiang Biota

The Taijiang biota is comparable in importance to the Chengjiang and Kaili biotas, both of which also occur in the Cambrian of China. Its discovery has filled in some major gaps in the Cambrian record of metazoan phyla and less taxa. The Taijiang biota is important in studies of early metazoan evolution and paleogeography, providing a critical window on biotic diversity following the Cambrian Explosion.

The Taijiang biota, discovered as the result of work on the Lower-Middle Cambrian boundary, also provides abundant additional material for use in determining the position of this boundary. Future work on the Taijiang biota promises to be highly rewarding.

图 版 说 明

所有图版的标本均存放于贵州工业大学资源工程系古生物及生物成矿研究所实验室。编号前者为采集号,(GTB 代表八朗乌溜剖面,GTBM 代表北侧的苗板剖面),后者为登记号。

图 版 Ⅰ

1,3. *Sphenothallus taijiangensis* Zhu et Van Iten
1. 单枝状虫管,×5;GTB-9-2-189,GK9501; 3. 多枝状虫管,×4;GM-6-2-119,GK9502。

2. *Scenella radians* Babcock et Robison
外伞面,×10;GTB-8-2-322,GK2010。

4,5. *Byronia natus* (Liu, 1986)
4. 大型较完整虫管,×2,GTB-8-3-106,GK9503;5. ×8;GTB-9-1-550,GK9504。

6. *Bathynotus gaotanensis* Zhang et Li
背甲,×2;GTB-6-3-25,GK4402。

图 版 Ⅱ

1. Echiurid?
完整虫体,不分节,环纹明显,×3;G1-6-42,GK3401;台江革东川硐。

2. Annelida?
有头尾之分,×3,G3-4-15,GK402。

3. *Hazelia* sp.
×7;GTB-8-3-26,GK7301。

4. *Wiwaxia taijiangensis* Zhao, Qian et Li
背部骨片,×2;GTB-9-2-250,GK2032。

5. *Chancelloria eros* Walcott
骨针,×8;GTB-9-1-66,GK7302。

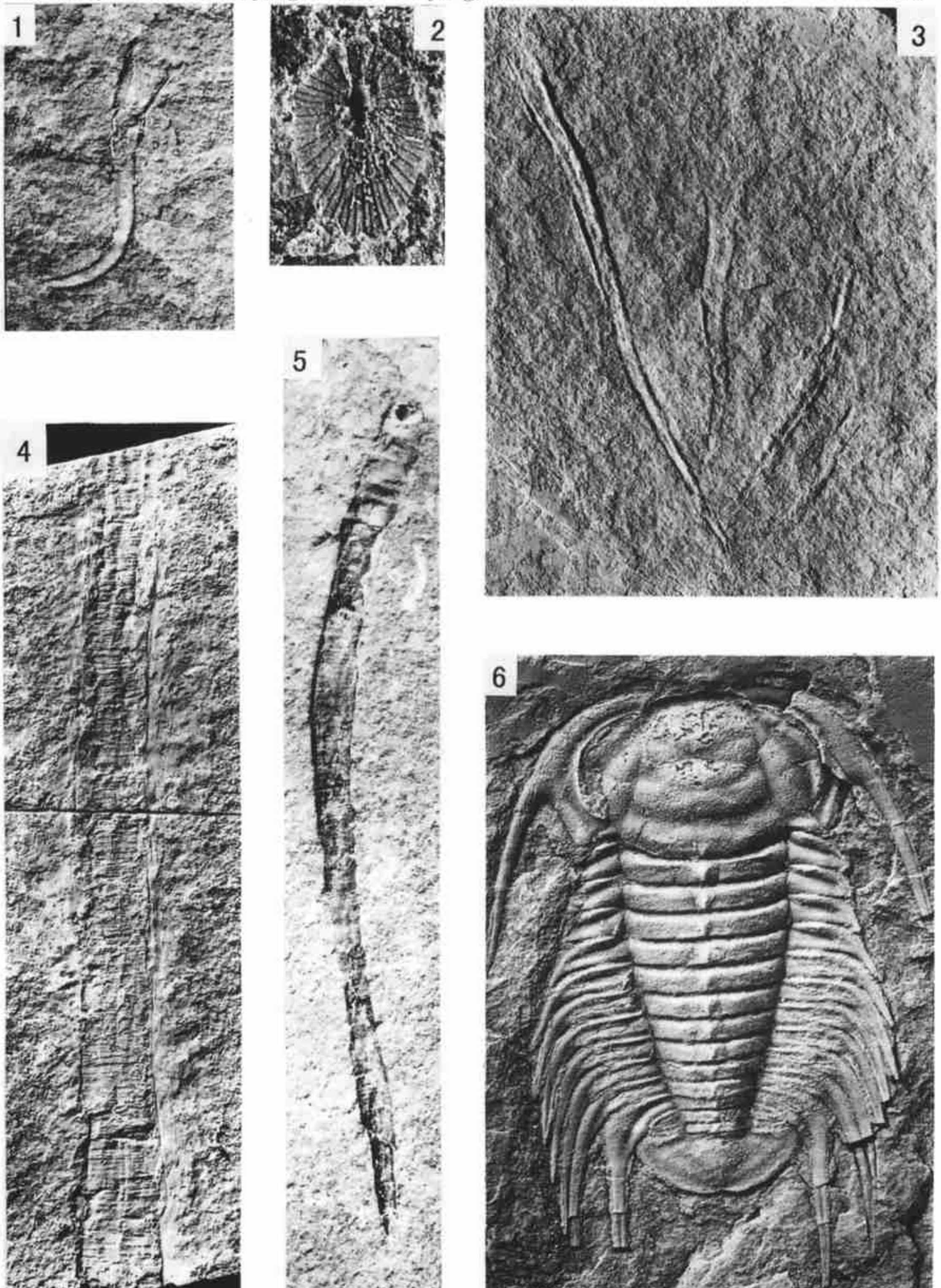
6. Arthropoda gen. et sp. nov.
背甲,×3;GTB-9-0,GK8601。

7. *Scenella radians* Babcock et Robison
外伞面,×18;GTB-8-2-325,GK2011。

8. *Sphenothallus taijiangensis* Zhu et Van Iten
楔形虫(未定种)虫管,×4;GTB-7-2-10,GK9505。

9. *Redlichia* (*Redlichia*) *taijiangensis* Guo et Zhao, 1998
×4;GTB-8-2-2,GK4405。

10. Dictyspongiidae gen. et sp. indet
×10;GTB-7-2-97,GK7312。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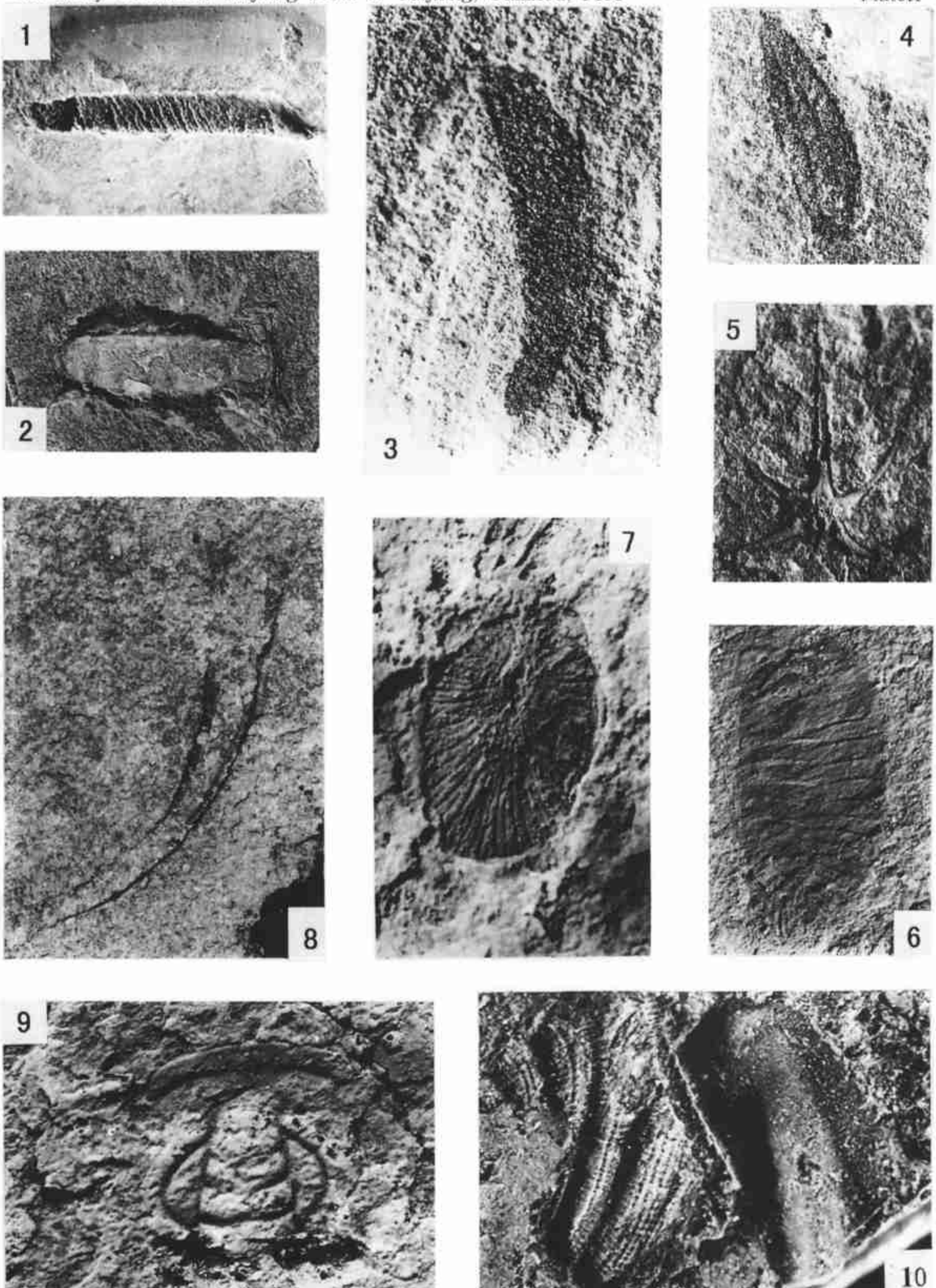
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