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贵州遵义下寒武统牛蹄塘组早期后生生物群的发现及重要意义*

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提要 贵州下寒武统牛蹄塘组生物群由大量的海绵动物和节肢动物、软体动物、刺胞动物、腕足动物、半索动物及藻类等门类化石组成,其下部生物群的时代早于澄江生物群。

关键词 牛蹄塘组生物群 波兰生物群 下寒武统 贵州遵义

前言

1998 年 4 月 28 日至 5 月 1 日,德国柏林工业大学和贵州工业大学组成的"贵州上震旦统至下寒武统生物及地层研究组"在贵州遵义松林下寒武统牛蹄塘组下部研究 Mo、Ni 等多金属矿层时,M·Steiner、E·Wallis、赵元龙、郭庆军、周震及杨瑞东在该组的下、中、上部的地层中发现了大量的海绵骨针、低钙化的大型双瓣壳节肢动物、金臂虫类、*Naraoia*、藻类等化石。由于下部化石层位距下寒武统底部地层梅树村阶戈仲伍组顶界仅 3 至 4m,研究组认为它的时代早于澄江生物群的时代,是一次重要的发现。M·Steiner 首次就遵义下寒武统牛蹄塘组生物群的发现于 1998 年 8 月底在瑞典 Lund 的国际寒武系会议上作了报道(Steiner *et al*.,1998)。1998 年 11 月及 1999 年 4 月,赵元龙、郭庆军等再赴遵义松林进行短期采集,在下部化石层位中又采集得大量的海绵、大型双壳节肢动物、藻类及重要的半索动物杆壁虫类化石。

在这次发现以前,M·Steiner、B.-D.Erdtmann 等在湘西北同一层位中发现了很多海绵骨针、大型双壳节肢动物、藻类化石(Steiner *et al*.,1993)。M·Steiner 等结合湘西北的发现,根据牛蹄塘组下部化石层位紧位于钼、镍、钒等的多金属矿层之上这一普遍现象,认为两者有密切关系。

本文仅就生物群的组成、时代及意义进行较为深入的探讨。

1 生物群组成

生物群产于遵义松林镇以西 5km 左右的中南村黑沙坡下寒武统牛蹄塘组(插图 1)。牛

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蹄塘组出露厚度 62m 左右,顶部不全。中下部由黑色、灰黑色粉砂质泥岩组成。近底部为高炭质页岩含钼、镍、钒等的多金属层,与下部戈仲伍组的硅质磷块岩及硅质岩相接触(插图 2)。上部为黄绿色含砂质泥岩、灰黑色泥岩。初步采集显示,该组化石集中分布于下部、中部及上部 3 个层位(插图 2,3)。

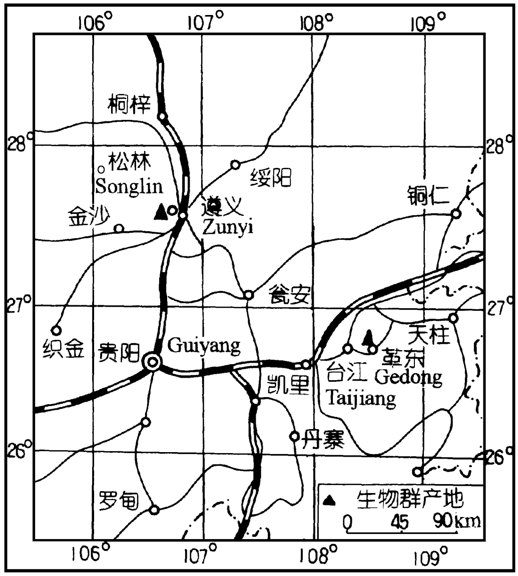

插图 1　贵州松林牛蹄塘组生物群及台江凯里、台江生物群地理位置图

Map showing the locations of the Niutitang biota of Songlin, Zunyi and the Kaili biota and Taijiang biota of Balang, Taijiang, Guizhou

下部化石层位:主要包括剖面的 5—7 层。岩石为灰黑色粉砂质泥岩,常常风化为浅棕灰白色,化石丰富,保存及显露清楚,产大量的海绵、低钙化的大型双壳节肢动物及藻类等化石。计有:海绵 *Saetaspoingia* Mehl et Reitner, 1993, *Leptomitus* Walcott, 1886, *Solactiniella* Mehl et Reitner, 1993, *Hyalosinica* Mehl et Reintner, 1993, *Hunanospongia* Qian et Ding, 1988;大型双壳节肢动物 *Perspicaris* Briggs, 1977;金臂虫类? *Songlinella* Yin, 1978, *Tsunyiella* Chang, 1964;刺细胞动物虫管化石 *Byronia* Matthew, 1899;藻类? *Morania* Walcott, 1919;类似锯笔石的半索动物杆壁虫类及具肉茎的舌形贝类等化石。

中部化石层位:以剖面中的 11—13 层化石为主,距底界 18.4m 左右。岩石为黑色泥岩,黑色含粉砂质泥岩,风化为浅灰白色泥岩或微杂黑色浅黄色泥岩。采集到大量海绵化石,计有:*Hyalosinica* Mehl et Reitner, 1993, *Leptomitus* Walcott, 1886, *Solactiniella* Mehl et Reitner, 1993;大型双壳节肢动物 *Perspicaris* Briggs, 1977;三叶虫 *Tsunyidiscus* Chang, 1966, *Guizhoudiscus* S·G·Zhang, 1980 及类似锯笔石的半索动物杆壁虫类化石。

上部化石层位:主要为灰绿色泥岩及含粉砂质泥岩,含丰富的多门类的化石,主要的化石有大型双壳节肢动物 *Isoxys* Walcott, 1890, *Perspicaris* Briggs, 1977;三叶虫 *Tsunyidiscus* Chang, 1966, *Guizhoudiscus* S·G·Zhang, 1980;三叶形虫 *Naraoia* Walcott, 1912;刺细胞类 *Scenella* Billings, 1872;软舌螺类;藻类? *Morania* Walcott, 1919, cf. *Sinocylindra* Chen et Erdtmann, 1992 及其他分类位置未定的化石。

3 个层位的化石群,可归为两个生物群(插图 2,3)。上部层位为一单独生物群,称牛蹄塘组上生物群或遵义生物群(Steiner *et al*., in press),以 *Naraoia*, *Isoxys* 为特征,带有澄江动物群的色彩。虽然未见 medusiform fossils, priapulids 及金臂虫类,但是尚不能肯定这是它们的差异。中部化石层位以海绵骨针为主,这和下部化石层位很相似,两者均具有类似的锯笔石的杆臂虫类化石,其化石的组合特征也相似,同属一个化石群,称松林生物群或牛蹄塘组下生物群。

两个生物群的软躯体化石少,均属于非典型的布尔吉斯页岩型生物群。

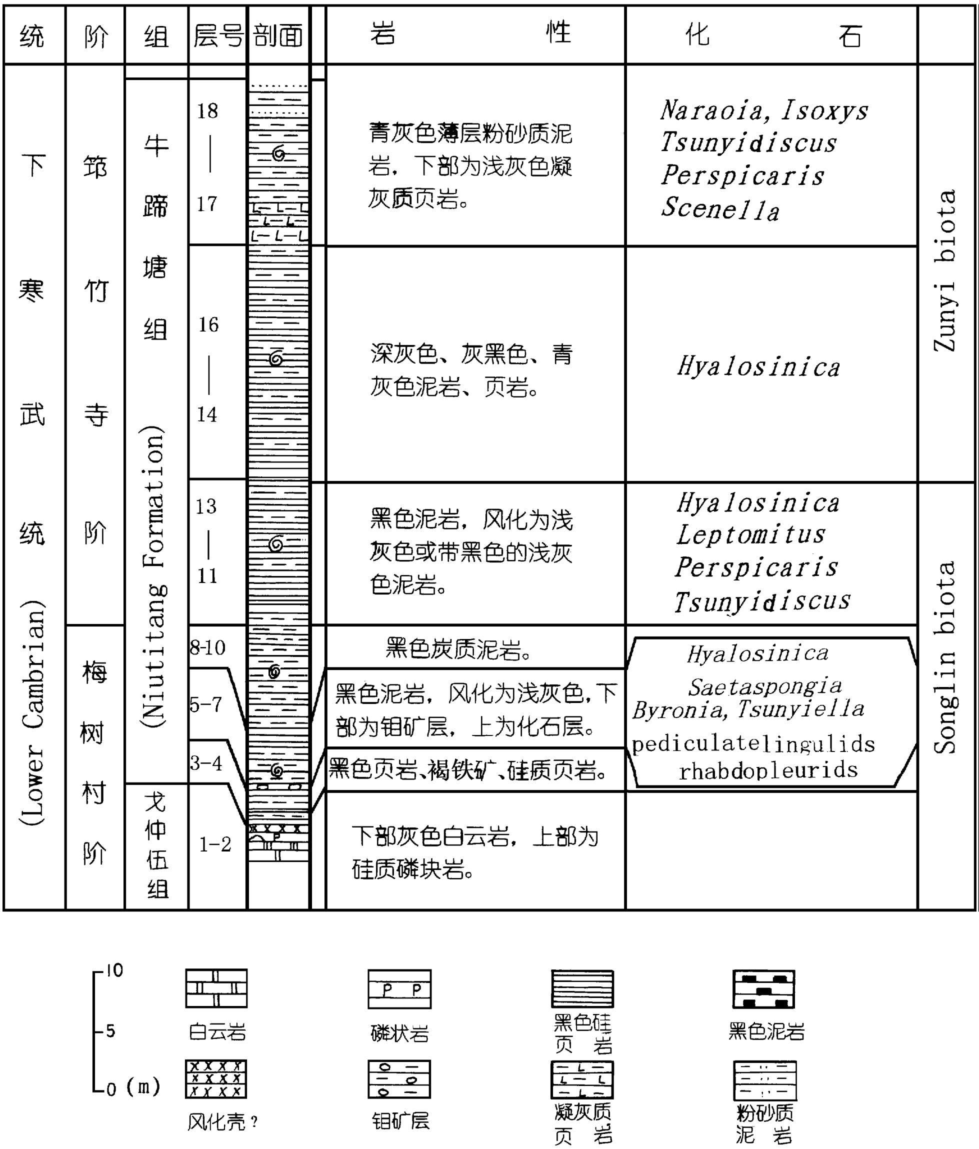

插图 2 贵州遵义松林下寒武统牛蹄塘组柱状图

The columnar section of Lower Cambrian Niutitang Formation at Songlin, Zunyi

2 生物群的时代

尽管目前对下寒武统的对比有不同的看法，但从多方面看，遵义下寒武统牛蹄塘组的下生物群的时代是相当早的，很可能相当于托莫特阶的晚期。

遵义松林一带下寒武统牛蹄塘组之下为戈仲伍组，由硅质岩、碳质页岩、磷块岩组成，是同一地层小区织金戈仲伍组的延伸部分(尹恭正，1987)。织金戈仲伍组白云质磷块岩中产有丰富的小壳动物化石，因含有 *Lapworthella*、*Siphogonuchits* 等小壳化石，相当于滇东梅

树村阶下部,顶界低于梅树村阶或基本相当(罗惠麟等,1994)。

<table>
<tr><th>系</th><th>统</th><th colspan="2">组</th><th colspan="3">化石组合</th></tr>
<tr><td rowspan="4">寒武系</td><td rowspan="4">下统</td><td rowspan="3">牛蹄塘组 (Niutitang Fm.)</td><td>上部</td><td>Isoxys , Perspicaris , Naraioa
Tsunyidisus , Scenella , Morania
hyolithids</td><td rowspan="2">Tsunyidiscus Assem.Z. ?</td><td>遵义生物群 Zunyi biota</td></tr>
<tr><td>中部</td><td>Hyalosinica , Leptomitus , Perspicaris
Solactiniella ,Tsunyidiscus ,Guizhoudiscus
, rhabdopleurids</td><td rowspan="2">松林生物群 Songlin biota</td></tr>
<tr><td>下部</td><td>Hyalosinica,Leptomitus,Paraleptomitella ,
Saetaspongia ,Solactiniella , Perspicaris,
Byronia , Songlinella , Tsunyiella ,
Pediculate lingulids , rhabdopleurids</td><td>Mianxiandiscus Assem.Z. ?</td></tr>
<tr><td colspan="2">戈仲伍组</td><td colspan="3"></td></tr>
<tr><td>震旦系</td><td>上统</td><td colspan="2">灯影组</td><td colspan="3"></td></tr>
</table>

插图 3　贵州遵义松林下寒武统牛蹄塘组化石群组合表

The fossil assemblage of Lower Cambrian Niutitang Formation from Songlin, Zunyi, Guizhou

遵义-织金-习水一带牛蹄塘组下部产 *Mianxiandiscus*,纵向分布距底界仅数米至 10m,完全可以和滇东筇竹寺阶下部 *Parabadiella*-*Mianxiandiscus* 组合带对比。由于西伯利亚托莫特阶中部的化石 *Lapworthella* 已出现于滇东梅树村阶上部(罗惠麟等,1994;罗惠麟等,1996),所以托莫特阶可以与梅树村阶比较,但顶界高于梅树村阶,因此,遵义牛蹄塘组下部甚至中部化石层位应该相当于托莫特阶的上部。

遵义-黔中地区下寒武统明心寺组富产 *Dictyocyathus*, *Ajacicyathus*, *Agastrocyathus*, *Rotundocyathus*, *Consinocyathus* 等古杯(章森桂等,1984),其组合特征可与西伯利亚阿特达班阶上部地层的古杯组合对比,两者时代相当,位于其下的牛蹄塘组可与阿特达班阶下部及托莫特阶上部地层相当,而遵义牛蹄塘组下生物群层位则应与托莫特阶上部相当。

3 生物学及古地理学意义

1) 牛蹄塘组下生物群是最早的布尔吉斯页岩型生物群

目前作为最早的布尔吉斯页岩型生物群是波兰生物群(Conway Morris,1998,p.125,fig.56.)。该生物群发现于1975年,位于波兰华沙之东,距地面2 000多米的(钻孔中)下寒武统,以带软躯体的 *Livia*,*Cassubia* 为特征(Dzik *et al*.,1988),因与 *Mobergella* 共生,其时代可与西伯利亚阿特达班阶中部的 *Fallotaspis* 带对比。Conway Morrs(1998)将其置于托莫特阶与阿特达班阶阶之间。而时代与托莫特阶上部相当的遵义牛蹄塘组下生物群明显早于波兰生物群,因此,它是最早的布尔吉斯页岩型生物群。由于生物群产地牛蹄塘组下部露头出露较好,加之牛蹄塘组分布广泛,研究前景十分广阔。

2) 增加了早期后生生物的新信息

早期后生生物的研究已成为当今古生物学研究的热门课题。所发现的布尔吉斯页岩型生物群点也迅速增加。近些年来增添的重要的布尔吉斯页岩型生物群点有Sirius Passet生物群(Greenland)(Conway Morris and Peel,1987),Mount Cap生物群(Canada)(Butterfield,1994)及我国的下寒武统的台江生物群(赵元龙等,1998)。这次发现的牛蹄塘组生物群,使全球寒武纪各主要时期均有早期后生生物群,形成一个可供系统研究寒武纪早期后生生物演化及寒武纪大爆发的寒武纪系列生物群(插图4)。遵义牛蹄塘组生物群特别是下生物群的发现使这个系列生物群的下界与前寒武系与寒武系之间的界线距离更加靠近。

遵义牛蹄塘组上生物群即遵义生物群及台江凯里生物群中出现的 *Naraoia* 这一事实,再次证明 *Naraoia* 源于中国的推测是正确的(张文堂等,1985)。下生物群含有类似锯笔石的杆臂虫类化石表明半索动物出现的时代稍早于澄江生物群。值得一提的是遵义牛蹄塘组中及下部化石均保存在黑色含粉砂质页岩中,形成于整体还原环境下短期是氧化的环境中,处于陆棚坡水体较深的沉积环境(蒲心纯等,1993)。

3) 为寒武纪大爆发提供了重要的资料

前寒武纪生物的“贫乏”及寒武纪生物的大量出现所形成的寒武纪大爆发理论在前阶段广泛流行。随着前寒武系中发现寒武纪化石(Gehling,1987,1996;Brasier,Green and Shields,1997)、寒武系中发现前寒武纪化石(Jensens,Gehling and Driser,1998)及新的早期后生生物群不断被发现(张录易等,1999;朱士兴,1999)。人们对寒武纪大爆发的认识产生了深化,提出一些想法,认为大爆发力度不大(Conway Morris,1998)或认为前寒武纪的生物发展有3个辐射方向(Balavoine and Adoutte,1998)或认为寒武纪大爆发仅仅是第二次生物大爆发(牛绍武,1999)。作者认为古生物研究本身就有局限性,找到什么化石就有什么结论,而化石本身又有局限性,为此提出假设理论应一要谨慎为宜;二要不断修改理论。随着新化石资料的增多,寒武纪大爆发尽管可能还是大爆发,它爆发的程度究竟如何?爆发的具体进程如何?还要深入探讨,可能会有新的认识及结论。

遵义牛蹄塘组生物群中发现类似锯笔石的杆壁虫类化石及其他疑难化石将为这一问题的解决提供资料及佐证。

4) 为解决古地理及生物群起源提供了重要资料

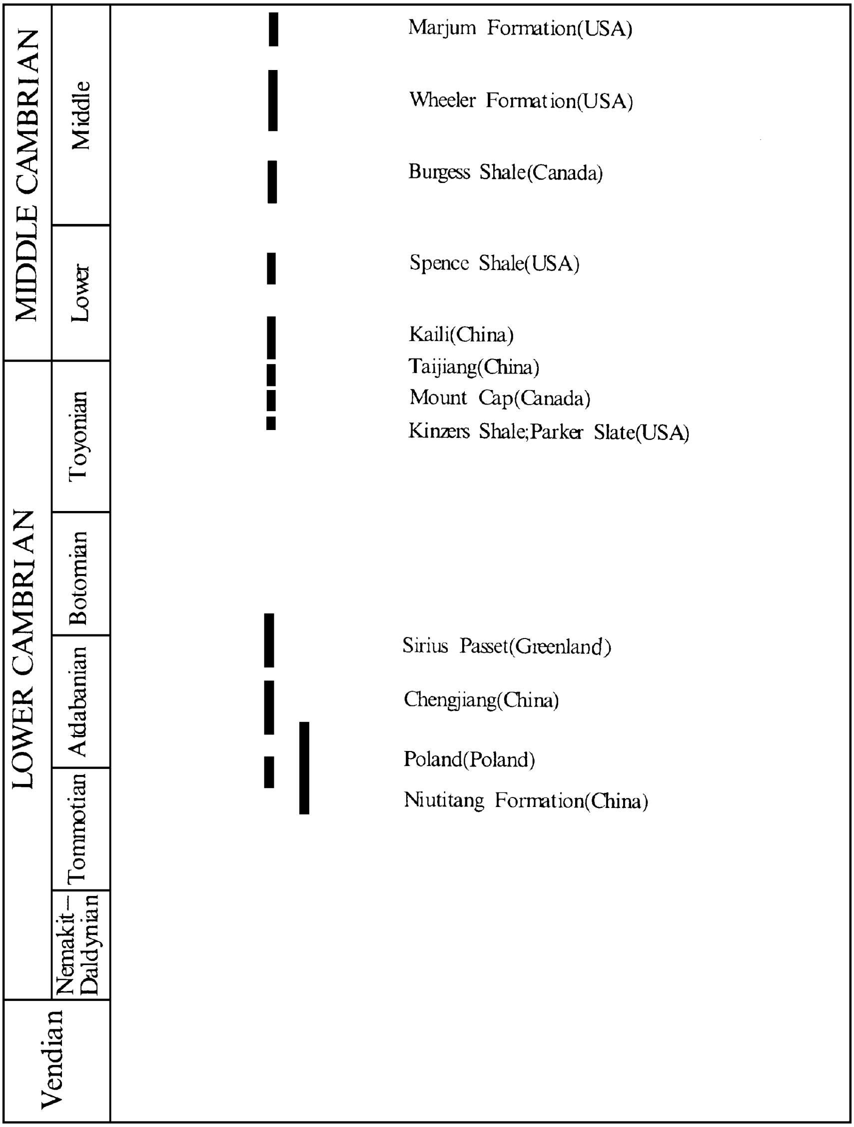

插图 4　全球主要布尔吉斯页岩型生物群时代、地层层位分布表
（据 Conway Morris，1998 补充）
Distribution of some principal Burgess Shale-type fossils localities in the Lower and Middle Cambrian
（Changed form Coway Morris，1998）

劳伦古陆和华南板块为何同时存在较多极为相似的布尔吉斯页岩型生物群？Conway Morris（1987）曾提出两者之间有通道相连的假设。随着凯里生物群、Sirius Passet 等生物群的出现，Conway Morris 又提出古太平洋的假说（Conway Morris，1998，p. 133，fig. 64），认为诸如澄江，布尔吉斯页岩等生物群可能是原始太平洋中移入深水的残留生物群。作者曾提出由于北美和华南有着极为相似的早期后生生物群及较多相同的三叶虫，应有相同或相似的古地理沉积环境，因此，寒武纪北美板块与华南板块的间距比目前认为的要近得多（赵元龙等，1996）。

随着遵义牛蹄塘组生物群的发现,凯里生物群突破性的进展及澄江生物群学术地位的陡升,可以初步设想,中国西南地区是全球寒武纪早期后生生物的重要发源地及研究基地。

5) 遵义牛蹄塘组生物群的发现说明早期后生生物尽管少,但比想象的要多。除了报道的Sirius Passet、台江、遵义生物群外,近期在西伯利亚等地也有少数的早期后生生物化石的报道(A·Yu·Ivantsov·,1998)。毫无疑问,这将鼓舞更多的古生物学家去寻找更多的早期后生生物群,随之而来的是更趋于实际的演化规律的出现。

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DISCOVERY AND SIGNIFICANCE OF THE EARLY METAZOAN BIOTAS FROM THE LOWER CAMBRIAN NIUTITANG FORMATION ZUNYI, GUIZHOU, CHINA

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In 1998, a research cooperation was started between the Technische Universität of Berlin and the Guizhou University of Technology. Its main task was study of the Upper Sinian to Lower Cambrian strata in Guizhou Province, China. A special, joint-field research team was formed by Dr. Michael Steiner and Ph.D. student Eckart Wallis from TU and Prof. Zhao Yuan-long, M.Sc. student Guo Qin-jun, Assistant Zhou Zhen and Ph.D. student Yang Rui-dong from GUT. From April 28th to May 1st, the joint team examined a section of the Lower Cambrian

Niutitang Formation at Songlin town of Zunyi Area. During the investigation of while they were observing a multi-metal layer containing Mo, V and Ni in the lower part of the Niutitang Formation, several fossils of different phyla were collected including: sponges, large bivalved arthropods, bradoriids, *Naraioa*, and algae. The lowermost layer containing those fossils is only 3 to 4 meters above the top of the Dengying Formation, which belongs to the Meishucunian Stage, which is basal Lower Cambrian. Therefore, we believe that the age of this fossil layer is older than the Chengjiang biota. This discovery is of importance.

In August, 1998, during an international meeting on the Cambrian that was held in Lund, Sweden, the discovery was reported by Dr. M. Steiner (Steiner *et al*., 1998). In November, 1998 and April, 1999, several sponges, large bivalved arthropods, algae and some undetermined fossils were collected in the lower fossil layer by Zhao Yuan-long and others, during his short-period field work at Songlin. Before this discovery, Steiner and others had found many sponges and large bivalved arthropods in the same strata from northwestern Hunan Province (Steiner *et al*., 1993).

Steiner M. *et al*. considered that there must be some relationship between the abundance of fossils of the lower fossil layer and the concentration of multi-metals underneath the lower fossil layer. After joint research by Zhao and Germans on those fossil specimens at TU Berlin, they decided to name the upper fossil layer as Zunyi biota (Steiner *et al*., in press).

Different from the former reports, this paper will discuss mainly about the composition, age and significance of the newly found biota from the Niutitang Formation.

1 COMPOSITION OF THE FAUNA

The fauna is occure in the Lower Cambrian Niutitang Formation at Heishapo of Zhongnan village, which is 5km west from Songlin Town, Zunyi (Text-fig. 1). The thickness of the outcrop of the Niutitang Formation there is more then 62m. Middle-lower part of it is composed of black and dark-gray silty mudstones. A high carbonaceous multi-metal layer containing Mo, Ni and V is located near the base, which contacts with siliceous phosphorite and silicated rock of the upper Gezhongwu Formation (Text-fig. 2). The upper Niutitang Formation is composed of yellow-green silty mudstones and dark-grey mudstones. Preliminary collection indicates that fossils in this formation are concentrated in three layers: lower, middle and upper layers (Text-figs. 2, 3).

1) The lower fossil layer: which occures within are mainly the 5th to 7th layers of the section. Rocks of these layers mainly consist of dark-gray silty mudstones, which commonly become light brownish-gray when weathered. Fossils in this layer are clearly and well preserved, and are mainly sponges; bivalved arthropods; and algae. Fossils collected in this fossil layer include:

Sponges: *Hyalosinica* Mehl et Reitner, 1993; *Leptomitus* Walcott, 1886; *Solactinella* Mehl et Reitner, 1993. *Saetaspongia* Mehl et Reitner, 1993 and (?) *Paralep-*

tomitella Chen in Hou et Lu, 1989

Cnidaria: *Byronia* Matthew, 1899.

Large Bivalved Arthropods: *Perspicaris* Briggs, 1977.

Bradoriids: ? *Songlinella* Yin, 1978; *Tsunyiella* Chang, 1964.

Brachiopods: Pediculate lingulids.

Algae: ? *Morania* Walcott, 1919.

Undescribed remains of rhabdopleurids.

2) The middle fossil layer: which are mainly the 11th and 13th layers of the section. Rocks are mainly black mudstones, with light gray appearance when weathered. Many sponge and other fossils collected in this fossil layer include:

Sponges: *Hyalosinica* Mehl et Reitner, 1993; *Leptromitus* Walcott, 1886; *Solactinella* Mehl et Reitner, 1993.

Trilobites: *Tsunyidiscus* Chang, 1966.

Large Bivalved Arthropods: *Perspicaris* Briggs, 1977.

Undescribed remains of rhabdopleurids.

3) The upper fossil layer: which are mainly grayish-green mudstones containing a few silt mudstones layers. This is a layer with abundant fossils of different phyla. Fossils collected in this layer namely:

Large Bivalved Arthropods: *Isoxys* Walcott, 1890; *Perspicaris* Briggs, 1977.

Trilobite: *Tsunyidiscus* Chang, 1966.

Naraoiids: *Naraoia* Walcott, 1912

Undetermined arthropod remains.

Cnidaria: *Scenella* Billings, 1872.

Hyolithids

Algae: ? *Morania* Walcott, 1919; cf. *Sinocylindra* Chen et Erdtmann, 1992.

These three fossil layers can be divided into two different faunas. The upper fossil layer was named as Zunyi biota (Steiner *et al*., in press) and is characterized by *Naraoia* and *Isoxys*. It is similar to the Chengjiang biota somehow. Although medusiform fossils, pripulids and bradoriids have not been found in this new biota, the composition of biota resembles the Chengjiang biota. The main components of middle fossil layer are sponge spicules, which is similar to the lower fossil layers. Both layers contain remains of rhabdopleurids and it can be defined as one biota named here as the Songlin biota.

2 AGE OF THE BIOTA

Although there are different ways to correlate the Cambrian strata, but in all ways of correlation the lower biota in Niutitang Formation is quite early, equal to the late Tommotian Stage. Just underlying the Niutitang Formation of Zunyi, the Gezhongwu Formation is mainly composed of siliceous rocks, carbonaceous shale and phosphates. It is the same formation that stretches from Gezhongwu, Zhijin County, which is located in the same small stratigraphic area. Small shelly fossils abound in dolomitic phosphates of the Gezhongwu Formation in Zhijin County. *Lapworthella*, *Siphogonuchites* and other small shelly fossils that have been collected from this formation indicated that the formation could be correlated with lower Meishucunian Stage of eastern Yunnan Province. The top boundary of the formation must be lower than that of the Meishucunian Stage or almost equal to it (Luo *et al*., 1994; Luo *et al*., 1996).

In the lower Niutitang Formation of Zunyi-Zhijin-Xishui area, *Mianxiandiscus* was found, with its lower stratigraphic range only several meters to ten meters above bottom of the Niutitang Formation. So the Lower Niutitang Formation here can be correlated with *Parabadiella-Mianxiandiscus* Ass. z, which has been collected in the lower Qiongzhusi Stage of eastern Yunnan Province (Yin, 1987). *Lapworthella* was found in upper part of the Meishucunian Stage of eastern Yunnan. It is also was found in the middle Tommotian Stage of Siberia (Luo *et al*., 1994; Luo *et al*., 1996); therefore, the Tommotian Stage can be correlated with the Meishucunian Stage with its top higher than the Meishucunian's. So the lower and middle fossil layers of the Niutitang Formation in Zunyi can be correlated with the upper Tommotian Stage.

The abundance of archaeocyathids, such as *Dictyocyathus*, *Ajacicyathus*, *Agastrocyathus*, *Rotundocyathus* and *Consinocyathus* (Zhang *et al*., 1984), shows that the overlying Minxinshi Formation is equal to the upper Atdabanian Stage of Siberia, and the Niutitang Formation is equal to the lower Atdabanian and upper Tommotian. It is reasonable to compare the lower biota of the Niutitang Formation of Zunyi with the upper Tommotian Stage.

3 SIGNIFICANCE

1) It is the earliest Burgess Shale-type fauna

At present, the earliest known Burgess Shale-type fauna is located in Poland (Conway Morris, 1988, p. 125, fig, 56). It was discovered in 1975, in the Lower Cambrian drill core that is more than 2 000 meters underground east of Warsaw. *Livia*, *Cassubia* and fossils with soft body preservation characterize this fauna. As it is associated with *Mobergella*, it can be correlated with *Fallotaspis* Zone in the middle Atdabanian Stage of Siberia. Conway Morris (1988) put it ranging from the Tommotian to Atdabanian Stage. The Shonglin biota in the Niutitang Formation can be correlated with the upper Tommotian Stage and is obviously earlier than the fauna from Poland. In Zunyi area, exposure of its outcrop is better, and it should be distributed extensively in some other provinces, therefore research on it would be producitive.

2) Increasing new information about Metazoa

Research on early Metazoa has become a popular aspect of paleontology now. Some Burgess Shale-type faunas are the Lower Cambrian Sirius Passet biota (Greenland) (Conway Morris and Peel, 1987), Mount Cap Fauna (Canada) (Butterfield, 1994), Taijiang biota (China) (Zhao *et al*., 1998) and the Zunyi bioty that was recently discovered. There are representatives of early metazoan fauna for each primary period of the Cambrian all over the world

(Text-fig. 4), which forms a series of fauna that can be used in a systematic study of the early evolution of Metazoa in the Early Cambrian and the Life Explosion in Cambrian. Discovery of the biota in the Niutitang Formation of Zunyi, especially the lower biota makes this series of faunas extend down closer to the pre-Cambrian and Cambrian boundary. With *Naraoia* appearing in the Zunyi biota of the Niutitang Formation supports the hypothesis that *Naraoia* orginated in China (Zhang, 1985). The discovery of the rhabdopleurids is important. It is worth mentioning that the lower and middle fossil layers (Songlin biota) of the Niutitang Formation are preserved in black silty shale. These layers formed in a short period of an oxidizing environment under generally reducing conditions and indicates the Songlin biota lived in the deeper waters of the outer shelf (Pu *et al*., 1993). This origin is similar to that of the Chengjiang biota, but different from the Taijiang and Kaili biotas, which are just located stratigraphically above, whose rocks are gray-green shales.

3) Provide important information for the definition of the Cambrian Explosion

The hypothesis of the Cambrian Explosion, which has prevailed in recent years, is based on the difference between low diversity faunas of the Precambrian and the extremely abundant faunas in the Cambrian. With the discoveries of typical Cambrian fossils in pre-Cambrian strata (Gehling, 1987, 1996; Brasier, Green and Shields, 1997), typical Pre-Cambrian fossils in Cambrian strata (Jensens, Gehling and Driser, 1998) and with new biotas continuously being discovered (Zhang *et al*., 1999; Zhu, 1999) the knowledge about the Cambrian Explosion increased. Some scholars advanced that the scale of Cambrian Explosion is smaller than we previously considered, some others posed that the life of pre-Cambrian evolved into three different branches (Balavoine and Adoutte, 1998) or considered that Cambrian Explosion is a second explosion (Niu, 1999).

As the authors' opinion, we should be more cautious in advancing a new theory. There are constraints in the research of paleontology. We only can draw out conclusion from the fossils we discovered, but the fossil specimens also have confinement itself. With more fossil material discovered, will we found out that the scale of Cambrian Explosion is as we previously considered?

Problematic fossils seen as undescribed remains of rhabdopleurids found in Niutitang Formation will provide information and evidence for the resolution of the problem.

4) Provide information for determination of origin of the fauna and its paleogeography

Why there are so many Burgess Shale-type faunas that are extremely alike in North America and South China? Conway Morris (1987) supposed that there should have been some connecting pathways between these two plates. However, after the discovery of Kaili biota and Sirius Passet Fauna, he put forward the palaeopacific hypothesis (Conway Morris, 1998, p. 133, fig. 64). He advanced that the Chengjiang biota, Burgess Fauna and some others must be remains of faunas transported into deeper water. We consider that because there are the same trilobites and other early Metazoa in North America and South China, the distance between North America and South China in the Cambrian must have been closer than previously considered (Zhao *et al*., 1996). With the discovery of the biota in the Niutitang Formation, Zunyi area, and the raising of Chengjiang biota's academic status, we can conceive that the southwest portion of China is one important origin area of Cambrian Metazoa.

5. Promote studying of early Metazoa

The discovery of the biota in the Niutitang Formation indicates that, although the amount of Metazoa is small, there are more than we considered. Other than those faunas have been previously reported, such as Sirius Passet, Taijiang, Zunyi biotas etc., a new fauna containing a few Metazoa have bee recently reported from Siberia (Ivantsov, 1998). These new discoveries surely will encourage palaeontologists in searching for more Metazoa fauna. Following that, a more reasonable evolution pattern should emerge.

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图 版 说 明

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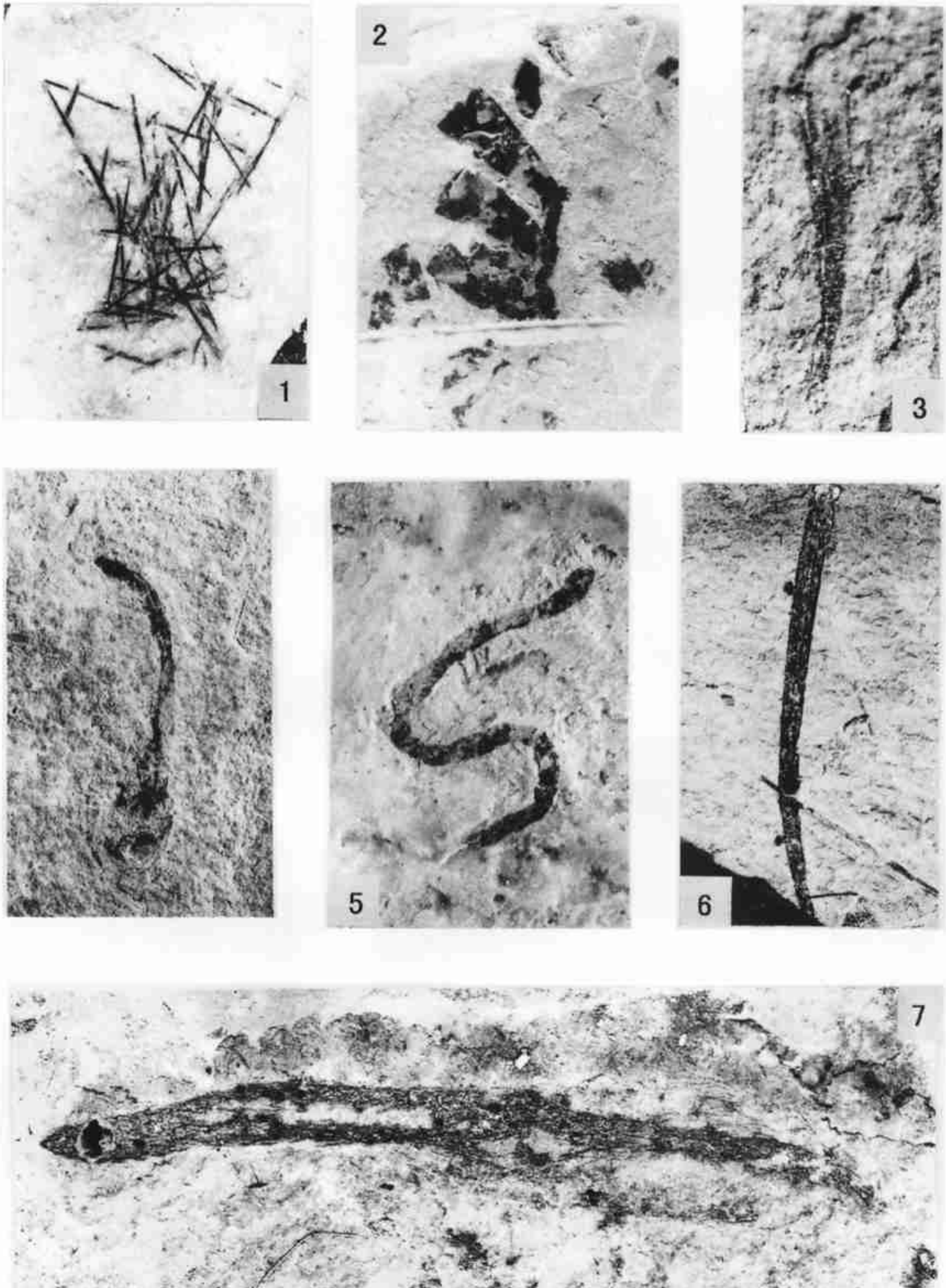
图版 I

1. *Solactinella* sp.(小阳光海绵未定种),×2;Sh-5-169,GZ1。
2. Rhabdopleurids gen. et sp. nov.(杆壁虫类新属种),×4;Sh-13-16,GZ2。
3. *Byronia* sp.(拜如尾亚虫未定种),内膜,×3;Sh-5-332,GZ3。
4. Pediculate lingulid(具肉茎的舌形贝类),×5;Sh-5-85,GZ4。
5. ? Sponge gen. et sp. indet(属、种未定的可疑海绵),个体呈蚯蚓状,见有骨针,×5;Sh-6-20a,GZ5。
6. ? *Takakkawia* sp.(疑问托凯克凯威海绵未定种),×6;Sh-5-75,GZ6。
7. ? *Paraleptomitella* sp.(疑问拟细丝海绵未定种),×1.5;Sh-6-206a,GZ7。

图版 II

1. *Perspicaris* sp.(锐虾未定种),×2;Sh-5-145,GZ8。
2. ? *Songlinella songlinensis* Yin(疑问松林小松林虫),×2.5;Sh-6-93,GZ9。
3. *Fieldospongia* sp.(原野海绵未定种),×3;Sh-5-168,GZ10。
4. *Tsunyidiscus tenellus* (S.G.Zhang)(美丽遵义盘虫),头盖,×10;Sh-14-18;GZ11。
5. *Scenella* sp.(帐篷螺未定种),×12;Sh-18-136;GZ12。
6. *Saetaspongia densa* Mehl and Reitner (密集鬃毛状海绵),×2.5;Sh-5-17,GZ13。
7. *Hunanospongia* sp.(湖南海绵未定种),×2;Sh-6-41;GZ14。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赵元龙等：贵州遵义下寒武统牛蹄塘组早期后生生物群的发现及重要意义　　图版 II

Discovery and Significance of the Early Metazoan Biotas from the Lower Cambrian Niutiang Formation, Zunyi, Guizhou, China　　PlateII