

Vermicular fossils in the Early Cambrian Xidashan Formation in the Quruqtagh region of Xinjiang, China*

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Abstract Large amounts of vermicular fossils and a minor amount of sponge animal fossils have been found in the Early Cambrian Xidashan Formation in the region of Quruqtagh, Xinjiang. Vermicular fossils are generally more than 50 mm long and 0.3—1.4 mm wide; their wrinkled lamellae are microfine with 3—10 pieces within the length of every each millimeter. The fossils are considered to be *Sabellidites cambriensis* Sokolov (1965). The Xidashan Formation is the highest stratum in which *Sabellidites* occur, as has been so far reported.

Keywords: vermicular fossil, Early Cambrian, Quruqtagh, Xinjiang.

Studies on early metazoan are a frontier and hotspot in the research field of paleontology at present time. Especially, the discovery of China's Chengjiang fauna has attracted attention of the world^[1—3]. The Tarim Platform, one of the three giant platforms in China and characterized by the well-developed Cambrian strata, is thought to be containing geologically significant early metazoan fossils in addition to small shell animal fossils. In the summer of 2004 we spent half a month making geological investigations along the route of Korla-Xingdi-Lop Nur and found large quantities of vermicular fossils in the lower part of the Lower Cambrian Xidashan Formation at Xingdi-Daban, Quruqtagh. This discovery is of scientific significance in the study of early metazoan in the Tarim Basin.

1 Geological background

Quruqtagh is located at the southern extension of East Tianshan Mountain, abutting on the Tarim Basin in the south and on the Bosten Lake in the north. Around the areas of Xinger-Xingdi-Lop Nur are developed Neoproterozoic-Early Cambrian strata, which approximately extends east-westwards. In 1931 Norin took the lead in describing the Precambrian in the region studied, and it was named the "Quruqtagh Series". In 1957 Hu et al. proposed a scheme of detailed stratigraphic division of the Sinian strata in

the Quruqtagh region. Later, Gao et al. systematically investigated the strata in this region^[4,5] and divided the Neoproterozoic strata, from the bottom to the top, into the Bayixi Formation, Zhaobishan Formation, Altungol Formation, Tereeken Formation, Zhamoketi Formation, Yukkengol Formation, Shuiquan and Hankalchough Formation, Xishanblaq and Xidashan Formation (Fig. 1). Among them, the basement of the Bayixi Formation, Tereeken and Hankalchough Formation are composed of diamictite, marking the three giant glacial periods on the Tarim Platform; the other formations are composed of sandstones and mudstones, siliceous rocks, etc., interbedded with minor limestone, argillaceous limestone and dolomite. Recently, Xu et al. determined the absolute age of 740 Ma on zircon from basalts at the bottom of the Bayixi Formation (personal communication). Meanwhile, they carried out carbon isotopic studies of the Sinian system in the Tarim Platform^[6]. In the long past, due to the occurrence of three glacial periods on the Tarim Platform, the stratopaleontological investigations in this region have been focused on the comparison of glacial deposits. Evidence shows that the Bayixi glacial period is corresponding to the Chang'an glacial period (Sturtian) in the Yangtze region and the Tereeken glacial period to the Nantuo glacial period (Lantian diamictite)^[5,7]. More recently, Xiao et al.^[5] have studied the varia-

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tion of C, O and Sr isotopes in the post-glacial carbonate cap in this suite of strata, and considered that the Tereken glacial period should be corresponding to the Nantuo glacial period, and the Hankalchough glacial period should be designated to the late Nantuo glacial period (Marinoan).

The Lower Cambrian Xishanblaq Formation is composed of thin-layered black siliceous rocks, argillaceous dolomite and phosphorite, with the horizontal lamellae-developed argillaceous dolomite overlying the Hankalchough Formation diamictite, i. e. post-glacial carbonate cap sedimentation. The argillaceous dolomite is overlain by black siliceous rocks, intercalated, at the bottom, with phosphorous siliceous rocks and phosphorites, and in the black siliceous rocks are contained large quantities of *Michrystridium*-like fossils^[8]. The Xidashan Formation is composed predominantly of black siliceous rocks, mudstone and black argillaceous limestone. The black

argillaceous limestone has turned grayish-white in color after it was weathered, and it contains lots of vermicular fossils and sponge animal fossils. The Middle Cambrian Mohershan Formation is composed of black thin-bedded microlite and dolomite, and contains a lot of trilobite fossils, e. g. *Lejopyge*, *Ptychagnostus*. Trilobite fauna is a bio-community featuring a benthic and floating style of life and it contains more *Zunyidiscus*-like fossils, just similar to the Xiadong-Diandong-type fauna.

The Xidashan Formation contains three trilobite fossil zones from the bottom upwards, i. e. the *Metaredlichioides-Chengkouia* Zone, *Tianshanocephalus* Zone and *Arthricocephalus-Changaspis* Zone. The above trilobite fossil zones all belong to the typical species prevailing in the middle-late Early Cambrian, corresponding to the Qiongzhusi period or the Longwangmiao period^[9,10].

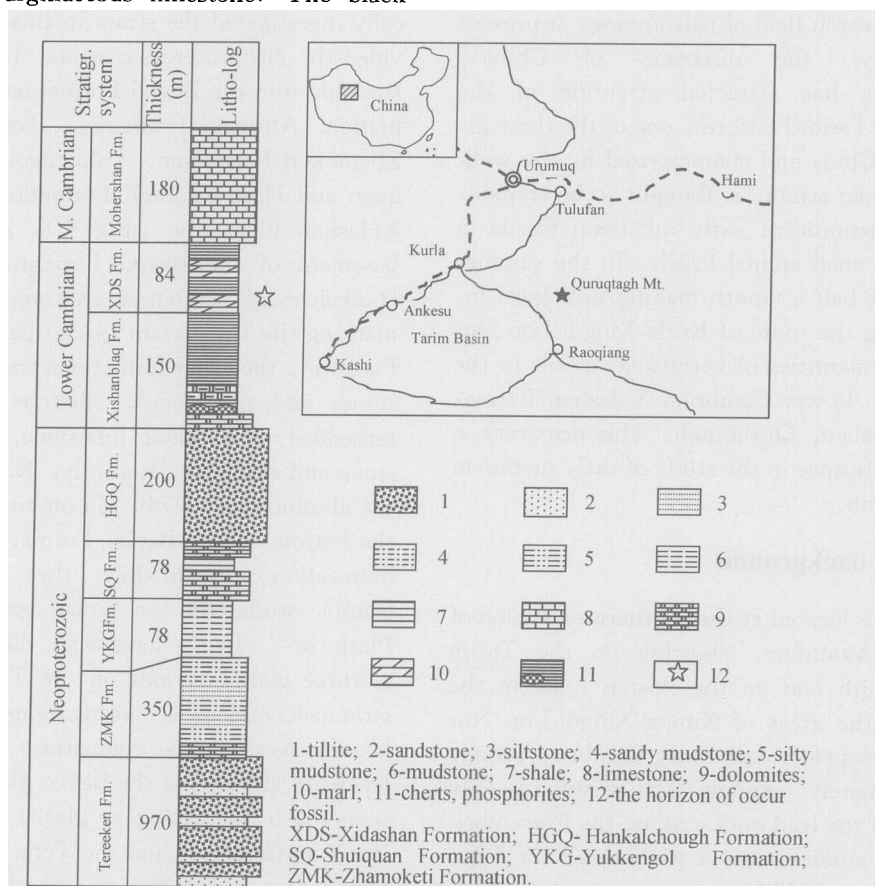


Fig. 1. Neoproterozoic-Early Cambrian strata and the fossil occurring horizon in the Quruqtagh region of Xinjiang.

2 Characteristics of the fossils

Argillaceous limestone in the Xidashan Formation at Xingdi-Daban, Quruqtagh contains large quantities

of vermicular fossils. Up to now more than 100 fossil specimens have been collected. After identification, it was found that those fossils belong to *Sabellidiites cambriensis* Yanichevsky (1926)^[11].

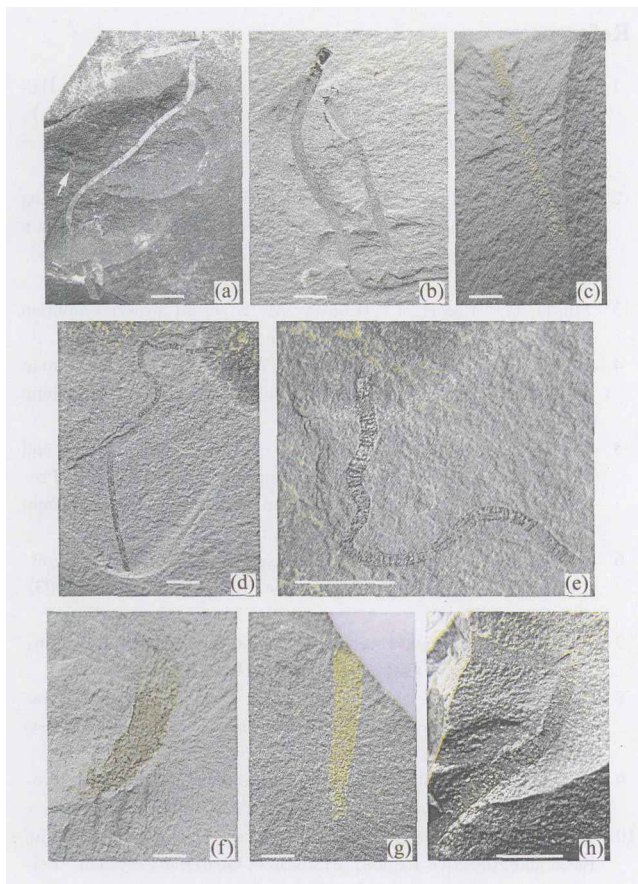


Fig. 2. Vermicular and sponge fossils found in the Xidashan Formation at Quruqtagh, Xinjiang. (a), (b), (c), (d), (e), (h): vermicular fossils *Sabellidites cambriensis*; (a) the arrow indicates vermicular fossils *Sabellidites cambriensis* (larvae); (f), (g): sponge animal fossils. Scale bar = 1 cm.

Vermicular fossils are one of the important types of early metazoan fossils. The oldest metazoan fossils so far discovered in China belong to the vermicular animal fossils *Sabellidites* sp., *Palaeoline tortusa* in the Huainan Biota, Anhui Province^[12,13], but this conclusion has not yet been accepted. Moreover, cf. *Sabellidites* sp. has been found in the Gaojiashan Formation in the southern part of Shaanxi Province^[14], cf. *Sabellidites* sp. has also been found in the Liuchapo Formation of the Upper Sinian, Hunan Province^[15]. Early Cambrian vermicular fossils have been discovered in various parts of China, but the most common vermicular fossils are *Sabellidites cambriensis* Yanichevsky^[11–16]. In recent years lots of new Early Cambrian vermicular fossils have been found in China, dominated by *Maotianshania cylindrical*, *Palaeoscolex sinensis*, *Cricocosmia jinningensis* in the Chengjiang fauna of Yunnan Province^[1,2,17]. In addition, such vermicular fossils as *Sabellidites yunnanensis*, *S. badaowangensis*, *S. wangjiawanensis* have been discovered in the early Early Cambrian

strata at Jinning, Yunnan Province^[18].

Sabellidites cambriensis Yanichevsky is a kind of vermicular fossils discovered in the Xidashan Formation at Xingdi-Daban, Quruqtagh, Xinjiang. The fossils are black in color, will become grayish-white and brown after weathered. They are mostly stringy, and gently curved and partly S-curved. Due to their large size and incomplete preservation in the strata, the fossils are present mainly in the form of fragments or blocks. The incomplete fossils are usually measured at 30–50 mm in length, with the maximum length up to 70 mm, and 0.3–1.4 mm in width. Wrinkles of the fossils are microfine. There are 3–10 pieces within the length of every each millimeter. In some specimens (Fig. 2(b)) there can be observed 7–10 pieces within the length of every each millimeter; in some other specimens (Fig. 2(e)) there may be 3–4 pieces within the length of every each millimeter. In the fossil there have not yet been found any dark-colored body lines (intestines) and so have bristle marks neither (Fig. 2(a), (b), (c), (d), (e) and (h)). The fossils are slightly wider at one end, and slightly darker at the wider end. In the black shales there are preserved vermicular fossils of various sizes, of which smaller ones are only about 10 mm long and 0.1 mm wide. They seem to be *Sabellidites cambriensis* Yanichevsky larvae fossil (Fig. 2(a)). On some specimens are likely coated with carbonaceous film (Fig. 2(b), (e) and (h)). However, in the more than 100 specimens, no inoculated fossil head and tail part have been found. For this reason, those fossils are still designated to *Sabellidites cambriensis* Yanichevsky.

At present, only vermicular fossils represented by *Sabellidites cambriensis* Yanichevsky and minor amounts of sponge animal fossils have been found in the metazoan fossils embedded in the black argillaceous limestone of Xidashan Formation (Fig. 2(f), (g)). In the black argillaceous limestone the abundance of vermicular fossils represented by *Sabellidites cambriensis* Yanichevsky is very high, and 5–10 pieces of complete or incomplete vermicular fossils represented by *Sabellidites cambriensis* Yanichevsky can be recognized in every each square decimeter of black argillaceous limestone, but the fossils are low in diversity, as evidenced by the existence of one genus only, i. e. *Sabellidites cambriensis* Yanichevsky.

In comparison with vermicular fossils in the Jiliqiao Formation at Huainan, Anhui Province^[6], fossils represented by *Sabellidites cambriensis* are large in size and have distinctive ring features. In addition the fossils are of little variation in width, are

expanded in both ends, and have no bristle marks. In comparison with vermicular animal fossils of the Gaojiashan Fauna in Shaanxi Province^[17], fossils represented by *Sabellidites cambriensis* are large in size, while those represented by *Maotianshania cylindrical* do not exceed 40 mm in length and 2 mm in width^[18]. Only 3 or 4 annuluses are recognized within the range of 1 mm; fossils represented by *Sabellidites cambriensis* Yanichevsky are generally 50 mm long, with 3–10 annuluses within the range of 1 mm, and such a phenomenon has not been observed that small holes are densely concentrated on the terminals or surfaces of the fossils *Sabellidites cambriensis* Yanichevsky. Fossils and algae represented by *Vendotaenia* are similar in shape to *Sabellidites cambriensis* Yanichevsky, though *Vendotaenia* usually displays distortion with wrinkles on the bodies^[19], which has distinctive ring features like fossils represented by *Sabellidites cambriensis* in the Xidashan Formation in the Quruqtagh region. What is obviously different is its uniform width. So it can be ruled out that the fossil is *Vendotaenia*.

3 Scientific significance of the discovery of fossils

Fossils represented by *Sabellidites* were first discovered in the Early Cambrian Baltic Stage on the Russian Platform. Later, fossils represented by *Sabellidites* and similar fossils, e.g. *Parasabellites*, *Paleolina*, *Saarina*, etc. were discovered successively in the Vendotanian and early Early Cambrian strata on the Siberia Platform of the Russian Platform, they all belong to *Sabelliditida* and are designated to Pogonophorae^[11,16,20]. Large numbers of fossils represented by *Sabelliditida* were also found in the Early Cambrian strata in China^[12–16], but the Cambrian *Sabelliditida* fossils and vermicular fossils in the Chengjiang fauna studied by Luo et al.^[19] should be designated to Nematomorphae^[1,2].

Fossils represented by *Sabellidites* discovered recently all occur in the Vendotanian and early Early Cambrian strata. Fossils *Sabellidites* in the Xidashan Formation (corresponding to the Early Cambrian Canglangpuian Stage) at Quruqtagh, Xinjiang, were discovered in the highest-horizon strata among all *Sabellidites* fossils, indicating that *Sabelliditida* had still existed during the late Early Cambrian period.

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References

- Chen J. Y., Zhou G. Q., Zhu M. Y. et al. The Chengjiang Biota—A Unique Window of Cambrian Explosion (in Chinese). Taipei: Press of National Natural Science Museum, 1995, 1–150.
- Hou X. G., Bergstrom J. Wang H. F. et al. The Chengjiang Fauna—Exceptionally Well-Preserved Animals From 530 Million Years Ago. Kunming: Yunnan Science and Technology Press, 1999, 1–170.
- Shu D. G., Luo H. L., Conway M. S. et al. Lower Cambrian vertebrates from South China. *Nature*, 1999, 402:42–46.
- Gao Z. J., Wang W. Y., Peng C. W. et al. The Sinian System in Xinjiang, China. Urumuqi: Xinjiang People's Publishing House, 1987, 1–173.
- Gao Z. J., Peng C. W., Li Y. A. et al. The Sinian system and its glacial deposits in Quruqtagh, Xinjiang. In: Research in Precambrian Geology, Sinian Suberathem in China. Tianjin: Tianjin Science and Technology Press, 1987, 186–213.
- Xu B., Zheng Y., Yao H. et al. C-isotope composition and significance of the Sinian on the Tarim plate. *Chinese Sci. Bull.*, 2003, 48: 385–389.
- Zhang E. P. Regional Stratigraphy in Northwest China. Wuhan: China University of Geosciences Press, 1998, 1–212.
- Xiao S. H., Bao H. M., Wang H. F., et al. The Neoproterozoic Quruqtagh Group in eastern Chinese Tianshan: evidence for a post-Marinoan glaciation. *Precambrian Research*, 2004, 130: 1–26.
- Zhou Z. Y. and Chen P. J. Bio-Stratigraphy and Geological Evolution in Tarim Basin. Beijing: Science Press, 1990, 1–366.
- Jia C. Z., Zhang S. B., Wu S. Z. et al. Stratigraphy in Tarim Basin and Adjective Region: Proterozoic-Quaternary System. Beijing: Science Press, 2004, 1–547.
- Sokolov B. S. Drevneyshie otlozheniya rannego kembriya; sabelliditidy. *Tezisy Dokl Vses Simp Paleontol Dokem* 25–30 Oct. 1965, 78–91.
- Wang G. X. Late Precambrian Annelida and Pogonophora from the Huainan of Anhui Province. *Bull. Tianjin Inst. Geol. Miner. Resources*, 1982, 6: 9–20.
- Sun W. G., Wang G. X. and Zhou B. H. Macroscopic worm-like body fossils from the upper Precambrian (900–700 Ma), Huainan district, Anhui, China and their stratigraphic and evolutionary significance. *Precambrian Research*, 1986, 31: 377–403.
- Chen M. E., Chen X. G. and Lao Q. Y. Upper Sinian metazoan fossils and its stratigraphical significance in South Shaanxi. *Scientia Geologica Sinica*, 1975, (2): 181–190.
- Tang T. F., Zhang J. M. and Jiang X. J. Late Sinian stratigraphy and the discovery of paleontology, and its significance in west Hunan and Hubei provinces. *Journal of Stratigraphy*, 1978, 2(1): 32–44.
- Zheng W. W. A new occurrence of fossil group of *Chuaria* from the Sinian system in north Anhui and its geological significance. *Bull. Tianjin Inst. Geol. Miner. Resources*, 1980, 1(1): 49–66.
- Zhang L. Y. The discovery of the Late Sinian Gaojiashan Biota from Ningqiang County, Shaanxi Province and preliminary study on the biota. *Bull. Xi'an Inst. Geol. Miner. Resources*, 1986, 13: 67–88.
- Sun W. G. and Hou X. G. Early Cambrian worms from Chengjiang, Yunnan, China: *Maotianshania* gen. nov. *Acta Palaeontologica Sinica*, 1987, 26: 299–305.
- Steiner M. Die neoproterozoischen Megaalgen Süidchinas. *Berliner Geowiss. Abh. (E)*, 1994, 15: 1–146.
- Luo H. L. and Zhang S. S. Early worms and trace fossils in Jinning and Anning County, Yunnan Province. *Acta Palaeontologica Sinica*, 1986, 25: 307–311.