



Tube construction and life mode of the late Ediacaran tubular fossil *Gaojiashania cyclus* from the Gaojiashan Lagerstätte

Yaoping Cai*, Hong Hua, Xingliang Zhang

State Key Laboratory of Continental Dynamics and Department of Geology, Northwest University, Xi'an 710069, China

ARTICLE INFO

Article history:

Received 23 May 2012

Received in revised form 24 August 2012

Accepted 25 September 2012

Available online 5 October 2012

Keywords:

Ediacaran

Fossil

Morphology

Paleoecology

South China

ABSTRACT

Gaojiashania cyclus is a phylogenetically problematic tubular fossil that is only known from the late Ediacaran Gaojiashan Lagerstätte in southern Shaanxi Province, South China. It is a cm-sized tube that consists of a series of repeated units. Each unit consists of a rigid ring and an originally flexible bucket-shaped tube wall. Each tube maintains a constant diameter. The rigid ring elements typically range from 1 to 2 mm in length, whereas the bucket components are more variable at 0.5–5 mm in length and are ornamented with transverse annuli. Tubes display curving, extension, and constriction at free angles, indicating the original flexibility of the bucket components. The construction of *G. cyclus* tubes is unique in both fossil and modern tubular organisms, and strikingly differs from that of other known Ediacaran and Cambrian tubular fossils. Integrated morphological, taphonomic, and paleoecological data suggest that *G. cyclus* may have exhibited a procumbent epibenthic life mode, possibly using the ring structures as anchors to microbially bound muddy substrate. The preserved tubes are interpreted as the original exterior of the organism, as opposed to a life-mode reconstruction as a tube-dweller. The currently available evidence suggests that *G. cyclus* had non-mineralized or weakly mineralized tubes, and its phylogenetic affinity remains unresolved.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

Late Ediacaran fossils provide important insights into our understanding of the evolutionary history of life forms at the Precambrian–Cambrian boundary (Narbonne, 2005). Among late Ediacaran fossil taxa, tubular fossils are one of the important populations. Paleobiological and paleoecological investigation on these early tubular fossil assemblages is a critical step to bridge the evolutionary gap between fossil biotas of the Ediacaran and Cambrian ages. However, the evolutionary history (e.g., rise, radiation, and extinction) of these tubular fossils are not systematically understood. Clearly, it is imperative and of importance to investigate late Ediacaran fossil biotas.

The 551–542 Ma Gaojiashan Lagerstätte, hosted in the middle to upper Dengying Formation, preserves a variety of phylogenetically problematic tubular fossils (Cai et al., 2012). One of these tubular forms, *Gaojiashania cyclus*, is a cm-sized tubular fossil that is only known from the Ediacaran Gaojiashan Member of the Dengying Formation in Ningqiang of southern Shaanxi Province, South China (Fig. 1). The genus *Gaojiashania* and its type species *G. cyclus* were established by Yang, Zhang, and Lin (in Lin et al.,

1986), and currently five species have been described under this genus: *G. cyclus*, *G. zonatus*, *G. annulucosta*, *G. caperata*, and *G. haihaoliangensis*. The original diagnosis of *Gaojiashania* and its species were largely based on taphonomic variations, such as the degree of compression and disarticulation as well as incomplete preservation. Here, we document new anatomic populations from exquisitely preserved fossil specimens to provide a more complete morphological reconstruction for *Gaojiashania*. From our systematic reevaluation, four of the five described *Gaojiashania* species are proposed to taphonomic variants of a single taxon, and *G. haihaoliangensis* is regarded as an invalid nomination. Our morphological and taphonomic assessments additionally suggest a possible epibenthic life mode for *Gaojiashania*.

2. Geological and stratigraphic setting

Ediacaran successions are widely exposed on the Yangtze Platform of South China. The study area (Fig. 1) sampled here is located in the northwest margin of the Yangtze Platform where Ediacaran sediments accumulated in platform facies (see Zhu et al., 2004). The Ediacaran System in the study locality consists of the lower Doushantuo and the upper Dengying formations and is overlain by the lower Cambrian Kuanchuanpu Formation (Fig. 2).

The Doushantuo Formation is divided into lower slate, sandstone, and conglomerate and upper carbonate. The successive

* Corresponding author.

E-mail address: yaopingcai@nwu.edu.cn (Y. Cai).

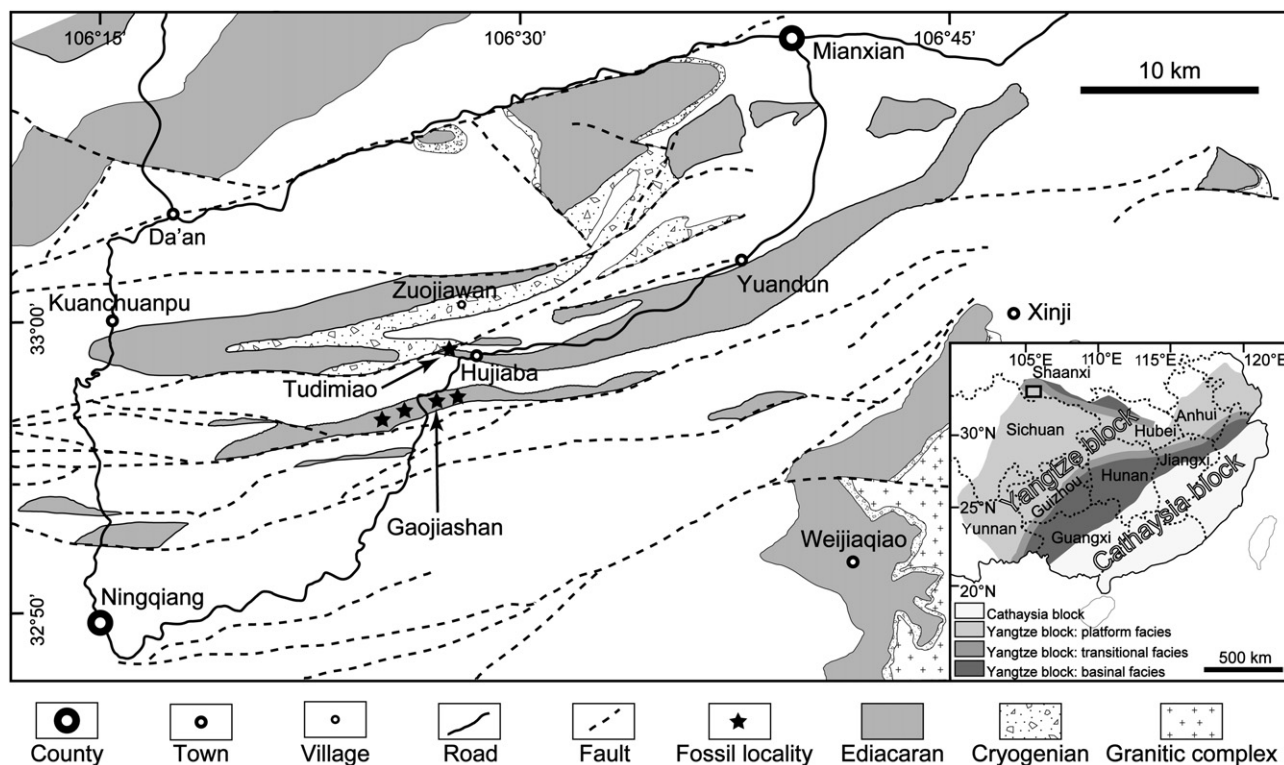


Fig. 1. Biostratigraphy of the Ediacaran Gaojiashan Member of the Dengying Formation at the Gaojiashan section. After Cai et al. (2011).

Dengying Formation is tripartite: the lower Algal Dolomite Member consists predominately of medium- to thick-bedded peritidal dolostone with algal laminae; the middle Gaojiashan Member is characterized by interbeds of fine-grained siliciclastics and carbonate; and the upper Beiwan Member consists of thin- to medium-bedded dolostone interbedded with chert in the lower part, medium- to thick-bedded dolostone in the middle part, and massive dolostone in the upper part. The overlying Lower Cambrian Kuanchuanpu Formation consists of phosphatic chert and bituminous limestone, yielding small shelly fossils and problematic fossil embryos and adults. In particular, the 55-m-thick Gaojiashan Member (Fig. 2) yields a variety of tubular fossils, including the *Gaojiashania* specimens examined here, as well as *Shaanxilithes*, *Conotubus*, and *Cloudina*. Deposition of the base of the Dengying Formation in the Yangtze Gorges area has been radiometrically constrained to have been deposited at ca. 551 Ma (Condon et al., 2005). Together with the Precambrian–Cambrian boundary radiometric age 542 Ma (Bowring et al., 2007), the maximum age range of the Gaojiashan Member is bracketed at 551–542 Ma (Fig. 2).

3. Materials, methods, and terminology

Fossils studied in this paper were collected from the middle Gaojiashan Member of the Dengying Formation at the Gaojiashan section (Figs. 1 and 2), Ningqiang County, southern Shaanxi Province, South China. All *Gaojiashania* fossils specimens are deposited in the Early Life Institute (ELI), Northwest University, Xi'an, China.

The *Gaojiashania*-bearing interval has a stratigraphic range of ca. 30–38 m from the base of the Gaojiashan Member. A total of 516 specimens were studied. The majority of *Gaojiashania* specimens were investigated under light microscopy and photographed under reflected light. A small fraction of pyritized fossils were studied using soft X-ray photography. These pyritized specimens show

sharp density and compositional distinctions from their surrounding matrix.

A suite of phylogenetically neutral morphological terms were used to describe the *Gaojiashania* specimens examined (see Fig. 3 for morphological reconstruction and annotations). *Gaojiashania* are preserved as curved, extended, or constricted cylindrical tubes, characterized by repeated units. Each of these repetitive units is composed of a rigid ring and a bucket-shaped tube wall ornamented by transverse annuli (ring and bucket hereafter).

4. Systematic paleontology

Uncertain affinities

Genus: *Gaojiashania* Yang, Zhang and Lin in Lin et al., 1986

Type species: *Gaojiashania cyclus* Yang, Zhang and Lin, 1986.

non *Gaojiashania haihaoliangensis* Zhang, Li and Dong in Li et al., 1992, pp. 102–103, 109 pl. XIV, Fig. 1.

Original diagnosis: Tube silkworm-like, straight or curved. Preserved parallel to bedding. Tube is composed of rings. Tube length 50–60 mm or longer. Ring diameter 7–9 mm, length 1–2 mm. [Translated from Lin et al. (1986) and Zhang (1986).]

Emended diagnosis: Straight (Fig. 4A–C) or curved (Fig. 4D and E) tubes. Tube wall consists of numerous units, each comprising a ring and a bucket (Figs. 4 and 5). Tube shows curving (Figs. 4D–E, 5A–D, and 6A, B, G), extension (Figs. 4C, E and 6G), and constriction (Figs. 4E and 5E) at free angles. Observed tube length typically 30–60 mm and can up to 180 mm in rare cases (Fig. 7). Ring diameters 4–12 mm (Fig. 7), length 1–2 mm.

Discussion: Previous morphological descriptions of the genus *Gaojiashania* (Li et al., 1992; Lin et al., 1986; Zhang, 1986; Zhang et al., 1992) have focused on the identification of rings preserved in various degrees of disarticulation and compaction. The original diagnosis of *Gaojiashania* emphasized the characteristic features that the tube consists of a series of rings (Lin et al., 1986). Chen et al.'s (2002) taphonomic and morphological interpretation

Download English Version:

<https://daneshyari.com/en/article/4723347>

Download Persian Version:

<https://daneshyari.com/article/4723347>

[Daneshyari.com](https://daneshyari.com)