EXTENDED PDF FORMAT
SPONSORED BY

BIO-RAD

http://discover.bio-rad.com



A Possible Lower Cambrian Chaetognath (Arrow Worm)

Jun-Yuan Chen, *et al.*

Science **298**, 187 (2002);
DOI: 10.1126/science.1075059

The following resources related to this article are available online at www.sciencemag.org (this information is current as of December 6, 2006):

Updated information and services, including high-resolution figures, can be found in the online version of this article at:
http://www.sciencemag.org/cgi/content/full/298/5591/187

Supporting Online Material can be found at:
http://www.sciencemag.org/cgi/content/full/298/5591/187/DC1

This article has been **cited by** 15 article(s) on the ISI Web of Science.

This article has been **cited by** 2 articles hosted by HighWire Press; see:
http://www.sciencemag.org/cgi/content/full/298/5591/187#otherarticles

This article appears in the following **subject collections**:
Paleontology
http://www.sciencemag.org/cgi/collection/paleo

Information about obtaining **reprints** of this article or about obtaining **permission to reproduce this article** in whole or in part can be found at:
http://www.sciencemag.org/help/about/permissions.dtl

Downloaded from www.sciencemag.org on December 6, 2006

Science (print ISSN 0036-8075; online ISSN 1095-9203) is published weekly, except the last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. Copyright c 2005 by the American Association for the Advancement of Science; all rights reserved. The title SCIENCE is a registered trademark of AAAS.

PALEONTOLOGY

A Possible Lower Cambrian Chaetognath (Arrow Worm)

Jun-Yuan Chen* and Di-Ying Huang

The phylum Chaetognatha (also called arrow worm), with only about 100 living species, is found in oceans throughout the world and plays an important role in the food web as primary predators (*1*). Its fossil record, however, is sparse. The Carboniferous *Paucijaculum samamithion* has been the only definitive fossil chaetognath (*2*). Some of the Cambrian protoconodonts could be grasping spines of this group (*3*). The Middle Cambrian *Amiskwia* was considered as a chaetognath (*4*), but with a sluglike head, terminal anus, and cephalic tentacles, it could well be a mollusk.

We report a probable chaetognath *Eognathacantha ercainella* from the Lower Cambrian Maotianshan Shale [about 520 million years (Ma) old] near Haikou, Kunming (South China). The single specimen is an adult, 25 mm long. A certain straightness in preservation suggests that the body in *Eognathacantha ercainella* may have been relatively rigid. It consists of a head, a trunk, and a possible tail (Fig. 1, A and C). The rounded head is wider than long (Fig. 1, B and D), measuring about 2.8 mm in width; it is wider than the rest of the body. Projecting anteriorly and laterally from the head are about 12 slightly recurved grasping spines, each about 900 μm long (Fig. 1B). As in modern chaetognaths, the spine bears an expanded base (Fig. 1B), which is likely embedded within the tissue (*5*). In the anterior part of head, there are numerous smaller spine-like structures (about 200 to 250 μm long) interpreted as possible teeth. In the middle part of head, there are numerous bluish papillae-like structures (about 150 μm long) surrounding a small slitlike structure interpreted as possibly a mouth (Fig. 1B).

A pair of transverse, cuplike structures at the posterior margin of the head is interpreted as muscle marks of a hood (Fig. 1, C and D). Such a hood is diagnostic of chaetognaths, and it is an extension of the epidermis, attached ventrally between the head and the trunk. The hood is provided with retractor and extensor muscles.

A thick brown layer envelope over the head is presumably a cuticle as in recent chaetognaths. This cuticle, however, disappears at the border between the head and trunk.

In contrast to the head, the trunk, 2.5 mm wide and 15 mm long, lacks evidence of a cuticle. The trunk epiderm, colored light yellow, presumably has no cuticle (Fig.1, A and C).

The posterior part of the body, about 8 mm long with a thick brown envelope, is considered as tail, which tapers posteriorly. If the envelope represents its cuticle, it differs from the cuticle-less tail of most living chaetognaths (*5*).

Modern chaetognaths usually bear paired lateral fins and a wide tail fin, all of which are supported by rays. *Eognathacantha ercainella*, however, preserves only a pair of narrow fins without fin rays (Fig. 1, A and C). The fins extend continuously from the anterior part of the trunk throughout the trunk and the tail. It is impossible to determine whether the fins are in the frontal plane of the body as in modern chaetognaths or otherwise. The fins have a uniform width of 0.4 mm wide, except throughout the anterior 2 mm, where they narrow anteriorly. No widening of the tail fin can be seen in this fossil form.

A bulbous structure at the anterior end of the trunk is presumably a pharynx (which is bulbate in modern chaetognaths), and this narrows posteriorly to join a slender, light bluish line, interpreted as the intestine (Fig. 1, A to D). This runs posteriorly, with a possible anus at its posterior end in front of the tail (Fig. 1A). The position of this possible anus, just anterior to the tail, corresponds to that of extant chaetognaths.

The Carboniferous fossil, *Paucijaculum*, represents the only previously known fossil Chaetognath and is poorly preserved. The grasping spines are the only trait definitely supporting the chaetognath identity. The general morphology of the Carboniferous *Paucijaculum* differs from that of our Cambrian species in having a smaller head and a tail fin that seems to be more similar to that of modern chaetognaths.

The affinity of the 520 Ma *Eognathacantha ercainella* with chaetognaths is supported by a widened head distinct from a trunk, presumably a tail (based on cuticularizaton in this fossil form), grasping spines and possible teeth on the head, and a hood on the border between head and trunk. The discovery of the Lower Cambrian chaetognath supports the hypothesis that all living animal phyla may have appeared in Cambrian times or even earlier, although only one-third of them have been recorded from Lower Cambrian.

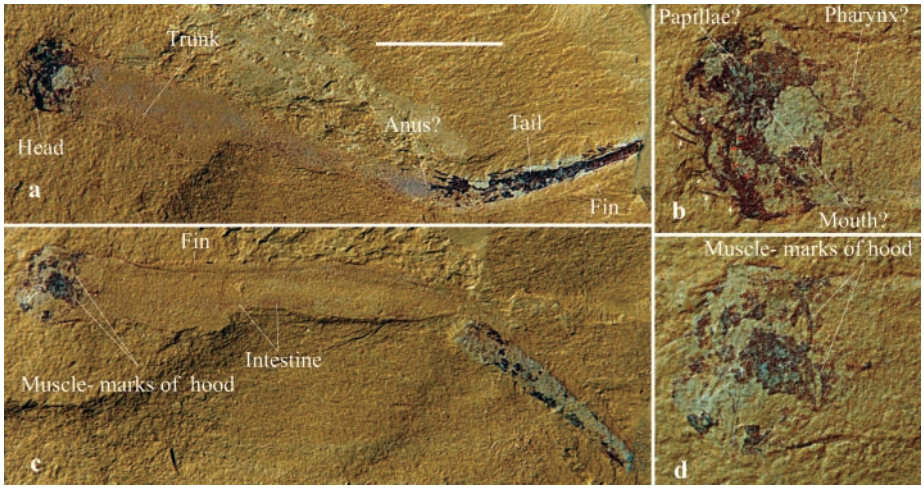


Fig. 1. The Lower Cambrian arrow worm *Eognathacantha ercainella* gen. et sp. nov., from the Maotianshan Shale, near Ercai Village, Haikou, near Kunming (South, China). (**A**) Ventral view of the holotype (EC02001a). (**B**) Enlargement of the head. Grasping spines, white arrows; teeth, red arrows. (**C**) Counterpart of holotype (EC01001b). (**D**) Enlargement of (C). Scale bar: 5 mm in (A) and (C); 2 mm in (B) and (D).

References and Notes

1. R. C. Brusca, G. J. Brusca, *Invertebrates* (Sinauer Association Sunderland, MA, 1990).
2. F. R. Schram, *J. Palaeontol.* **47**, 985 (1973).
3. H. Szaniawski, *J. Palaeontol.* **56**, 806 (1983).
4. C. D. Walcott, *Smithsonian Misc. Collect.* **57**, 109 (1911).
5. Q. Bone, H. Kapp, A. C. Pierrot-Bults, Eds., *The Biology of Chaetognaths* (Oxford Univ. Press, Oxford, UK, 1991).
6. We thank J. Mallatt for his valuable comments. This work was supported by National Science Foundation of China (grant 40132010) and the National Department of Science and Technology of China (grants 2000077700 and 9501).

Supporting Online Material
www.sciencemag.org/cgi/content/full/298/5591/187/DC1
Description information

[1]Nanjing Institute of Geology and Palaeontology, Nanjing 210008, China.

*To whom correspondence should be addressed. E-mail: chenjunyuan@163.net

Downloaded from www.sciencemag.org on December 6, 2006