The external and internal structures of *Amphizoa davidi* Lucas (Coleoptera, Amphizoidae), using X-ray phase contrast microtomography

DEE LI1,4, KAI ZHANG2,4, XIAOYAN LI1, PEIPING ZHU2, CAIFENG XU1, ZIYU WU2,3,5 & HONGZHANG ZHOU1,5

1Key Laboratory of the Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, 1 Beichen West Road, Chaoyang, 100101 Beijing, P. R. China
2Beijing Synchrotron Radiation Facility, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, P. R. China
3National Synchrotron Radiation Laboratory, University of Science and Technology of China, Hefei 230026, P. R. China
4Contributed equally to this study
5Corresponding author. E-mail: zhouhz@ioz.ac.cn; wuzy@ustc.edu.cn

**Abstract**

The Chinese endemic water beetle *Amphizoa davidi* Lucas, is a rare and endangered species belonging to the monotypic family Amphizoidae (Coleoptera: Adephaga). A study of the external and internal structures of *A. davidi* is here presented, by using X-ray phase contrast tomography and light microscopy. Morphological details and three dimensional (3D) structures of this species are provided: skeletons, muscles, reproductive organs of male and female, nervous system, alimentary canal and pygidial gland. The reproductive organs of females are compared in two different developmental phases (ages): before copulation without mature ovaries and after copulation with mature ovaries. Such detailed 3D tomographic study based on micro-CT technology may promote our understanding of the detailed morphology in Amphizoidae and Coleoptera in general.

**Key words:** external and internal structures, Coleoptera, Amphizoidae, *Amphizoa davidi*, three dimensions (3D), X-ray tomography

**Introduction**

Amphizoidae is a peculiar family of Adephaga in the speciose order Coleoptera, considered phylogenetically intermediate between Hydradephaga (water-living beetles) and Geadaphaga (ground-living beetles) (Kavanaugh1986). This family is monotypic, with the only genus *Amphizoa* Leconte, composed by five rare species, three of them reported to occur in North America and two in China. All the species of this family live mainly in fast-running cold water along mountain rivers at high altitude and occasionally on the adjacent terrestrial margins (hence the reference to the Greek term Amphip-). The study on this family can be traced back to the beginning of 19th century (Horn, 1867; Lucas, 1882). Wilson (1928) compared the male genital tube of members of this family. Edwards (1951; 1953; 1954) studied hind wings, genital morphology of males and females and the secretionary structure of some *Amphizoa* species. Forsyth (1970) investigated the pygidial gland of *A. lecontei* Matthews; Burmeister (1990) studied the female reproductive system of the same species. More recent studies have concentrated mainly on external morphology and musculature of the head and thorax: Dressler and Beutel (2010) observed the head structure and the muscle of *Amphizoa* in a general morphological investigation on Adephaga; Baehr (1979) studied the prothoracic skeleton and the procoxal muscles; Beutel (1988) described the metathoracic skeletons and musculature as well as the abdominal nerve cord of *A. lecontei* Matthews; Beutel and Hass (2000), finally, investigated the thoracic muscles of some *Amphizoa* species. As a comprehensive study of the family Amphizoidae, Xie (2000) significantly extended our understanding of the immature stages of this group and provided a large amount of valuable information about eggs, larvae, pupae and general biology.

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