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

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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) (Kavanaugh 1986). 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 *Amphi*-). 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 secretory 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.