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# Micro CT for 3-D reconstruction of brachiopod shells interior: an alternative to destructive serial sections

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First applied in medical investigations, the high resolution X-ray computer tomography (XCT) has been used within decades for a range of topics (Ketcham & Carlson, 2001), widening now to biology (Perez-Huerta et al., 2009), geology (e.g. mineralogy, vertebrate paleontology) and now invertebrate paleontology (Sutton et al., 2005; Nicollin & Hubert, Pakhnevich, 2010). Our attention focus on the internal structures of the brachiopod shells, particularly on the brachidium which is an essential point for the classification and consequently important to approach their phylogeny. The micro XCT tool allows observe internal morphological features and proceed to a 3-D reconstruction without destruction of the shell in contrast to the previous and classic method of transverse serial sectioning.

In this study representatives of Cretaceous rhynchonelliform brachiopods, with different types of brachial structure, have been analyzed to explore the potential and limits of the $\mu$CT imaging for invertebrate paleontology. For investigation we choose a variety of specimens such as Orbirhynchia boussensis Owen and Gemmarcula sp., which had different degrees of re-crystallization and filling (unknown to us before analyses). Micro XCT-images have been acquired using a Skyscan 1173 system. For reconstruction and 3D visualization we used commercially available programs. Spatial resolution – depending on specimen size and specific question – varies between 8$\mu$m and 20$\mu$m for these samples. Acquisition times varied between 20 min to 8h. We choose variable X-ray energies, filters and degree of sample rotation to optimize the acquisition conditions.

The 3D geometrical models reveal a wide range of potential, one can even image the pathway of punctae, for example. Even after short acquisition times (ca. 20min) the different parts of the brachial structure (e.g. crura, dental plates, pedicle teeth) could be clearly identified in a series (usually several hundreds) of tomography images. Thus micro-CT is an extremely effective method to image the internal structure of brachiopods and other fossils. It is non-destructive and fast. More sophisticated 3D reconstruction, modelling and visualization, however, can become time-consuming. Not all structures have sufficiently large attenuation contrast (e.g. carbonate fossils in a carbonate matrix) for useful imaging, and the sediment enclosed between the pedicle and the brachial valves might make 3D reconstruction difficult. However, reconnaissance imaging of samples can help to avoid such samples and provide guidelines for further optimal exploitation either by CT-imaging, geochemical sampling or traditional sectioning.

References

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