Zoosymposia 7: 53–70 (2012)
www.mapress.com/zoosymposia/

ISSN 1178-9905 (print edition)
ZOOSYMPOSIA
ISSN 1178-9913 (online edition)

Broad application of non-invasive imaging techniques to echinoids and other echinoderm taxa*

ALEXANDER ZIEGLER

Museum of Comparative Zoology, Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, MA, USA; E-mail: aziegler@fas.harvard.edu

In: Kroh, A. & Reich, M. (Eds.) Echinoderm Research 2010: Proceedings of the Seventh European Conference on Echinoderms, Göttingen, Germany, 2–9 October 2010. *Zoosymposia*, 7, xii+316 pp.

Abstract

Tomographic imaging techniques such as micro-computed tomography (μCT) and magnetic resonance imaging (MRI) permit the gathering of digital anatomical data from whole animal specimens non-invasively. The resulting datasets can be used for direct observation of the two-dimensional tomographic image data as well as for manual and semi-automated three-dimensional modelling. Freshly fixed specimens as well as preserved museum material can be successfully analyzed using this approach, giving the zoomorphologist a powerful tool for large-scale comparative studies. In order to demonstrate the principle suitability of non-invasive imaging in echinoderm research, μCT scans of 199 and MRI scans of 92 sea urchin (Echinodermata: Echinoidea) species were acquired, resulting in a total of 203 analyzed echinoid species. The taxa selected represent 50 of the currently recognized 60 extant sea urchin families. The present article lists all species that have been analyzed so far and provides information about the scanning parameters employed for each dataset. Furthermore, the workflow established to generate three-dimensional models of sea urchins is outlined. Using a number of examples from μCT as well as MRI scans performed on echinoids, the potential of the systematic approach described here is highlighted. Finally, the suitability of non-invasive imaging techniques for the study of other echinoderm taxa is assessed based on multimodal datasets of representative species.

Key words: Micro-CT, μCT, MRI, Echinodermata, Echinoidea, imaging, 3D visualization

Introduction

Micro-computed tomography (μCT) and magnetic resonance imaging (MRI) can currently be considered the most promising non-invasive techniques for imaging of whole specimens at the centimeter scale (Walter *et al.* 2010). While MRI provides excellent soft tissue contrast (Jakob 2011), μCT can be used to gather information primarily on hard tissues (Stauber & Müller 2008). Over the course of the last five years, I have employed both methods to visualize soft and hard parts in sea urchins (Echinodermata: Echinoidea). Because μCT and MRI are in principle entirely non-invasive imaging techniques, museum material (including type specimens) was successfully integrated into this study, resulting in an unprecedented taxon sampling for comparative morphological purposes. The acquired datasets can be used for computer-based two-dimensional (2D) as well as three-dimensional (3D) visualization and interaction in real-time. In fact, sea urchins constitute the first metazoan taxon to have been systematically documented on such a broad scale using the two complementary imaging

Accepted by A. Kroh & M. Reich: 6 Oct. 2012; published 12 Dec. 2012