The soft tissue fossil record to elucidate the origin and diversification of vertebrates

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Introduction:

The origin and diversification of vertebrates is a major event in the history of life on earth. A rich and well studied fossil record of jawed and jawless fishes exists following the advent of biomineralized hard tissues such as bone, but prior to this we are limited the soft tissue record. Soft bodied fossil vertebrates have the potential to help us understand the timing of key vertebrate innovations, including biomineralization itself. Indeed some taxa have been interpreted as exhibiting a kind of transitional state between the two conditions. The fossil record of soft bodied taxa is challenging however; the remains are subjected to decay, collapse, and distortion before and during preservation. These challenges have led to some disputes and a lack of consensus exists over the anatomy and affinity of these important fossils. New fossil discoveries, along with recent advances in scanning technology and a wealth of experimental decay data, means that it is now possible to she new light these previously enigmatic taxa and the nature of this important evolutionary event.

Project Summary:

This project aims to study the soft-tissue fossil record of early vertebrates in terms of their anatomy, affinity, preservation, and geochemistry to reconstruct the origin and early diversification of vertebrates. The techniques applied will range from the traditional to the state of the art. Re-study of the Silurian vertebrate *Jamoytius* demonstrates that objective analysis of multiple specimens will enable a test of conflicting interpretations of anatomy, including possible biomineralized tissues (Sansom et al. 2010). Application of experimental decay data also provides an additional analytical tool to identify decayed anatomy and to make the distinction between anatomy that is missing due to taphonomic loss or phylogenetic absence (Sansom et al. 2011). Indeed, conflict over the affinity of the fossil taxa may relate to taphonomic biases such as 'stem-ward slippage'. Furthermore, application of X-ray fluorescence (XRF) and synchrotron technology will enable detailed geochemical characterization of the composition and preservation of early vertebrate tissues (Edwards et al. 2013). These combined approaches will make it possible to elucidate the anatomical features of the soft-bodied early vertebrate fossil taxa, consider them in a phylogenetic framework, and test hypotheses relating to the evolution of biomineralization and other fundamental vertebrate innovations.

The studentship will involve a diverse array of analytical techniques supported by the thriving cross-disciplinary research area at the University of Manchester. A large group of academic staff and associated researchers are addressing evolutionary and palaeobiology questions through studying ancient life, supported by Manchester's Interdisciplinary Centre for Ancient Life (http://www.ical.manchester.ac.uk/) and the Computational Biology group in the Evolution, Systems and Genomics Domain https://www.bmh.manchester.ac.uk/research/domains/evolution-systems-genomics/). They will have access to world-class facilities in the William Research Centre for Molecular Environmental Sciences. The student working on this cross-disciplinary project will gain a wide breath of training in palaeontology, taphonomy, phylogenetics, and organic geochemistry, and would suit a student from a geological or biological background with some experience of palaeobiology.

Image 1 – The Silurian vertebrate *Lasanius* yields an interesting mix of biomineralized hard characters and soft tissue preservation

References

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