Linking Experimental Decay to the Fossil Record

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Introduction:

The exceptionally preserved fossil record of soft tissues provides unique insights on a range of important evolutionary events, from the Cambrian explosion to the feathers of dinosaurs. Interpretation of the soft tissue fossil record is more challenging than the conventional fossil record. Anatomy is incomplete and distorted, having been subjected to loss and change through decay and preservation. Those processes of decay can be experimentally investigated on a laboratory timescale under controlled conditions. A recent resurgence in experimental decay had revealed important sources of bias and a new understanding of preservation processes. However, in many respects the applicability of experimental data to the actual fossil record remains unclear; many fundamental experimental parameters have not been tested. Are the chemical, biological and physical parameters of experiments realistic given geological parameters? Can results be generalized given variability in sediments and microbial ecology? How do these considerations affect interpretations of the fossil data? This project aims to test the validity of experimental taphonomy by investigating processes of decay, their applicability to the fossil record and thus the evolutionary inferences drawn.

Project Summary:

This project aims to test the validity and applicability of decay experiments in the context of interpretation soft tissue morphology in fossils. Two key parameters will be experimentally investigated in this context using standard animal decay models (e.g. arthropods, annelids, soft-bodied chordates): 1) The presence and type of encasing sediment as compared to the common experimental null medium – artificial seawater. This presents technical challenges for which will we apply innovative experimental solutions, including 3D microtomography. 2) The presence and type of microbial flora present around and in the decaying carcass. Not only will the microbial flora be manipulated, but the flora responsible for decay will also be characterized molecularly. Both sediments and microbes have been suggested as important factors in decay, but neither have been directly investigated in the evolutionary context of anatomical character change and loss. Furthermore, interaction between the two factors remains uninvestigated. The combined experiments will therefore provide a better understanding of not only the geological processes of soft tissue fossil formation and the conditions necessary, but also how morphology is transformed during decay and the impact this has on evolutionary interpretations. Finally, the identified patterns of morphological change and loss in the laboratory under the various conditions will be compared with empirical data i.e. that observed fossil deposits. This will enable not only a test of the applicability of experimental decay to real world situations, but also inform our understanding of important empirical evolutionary events.

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/). The majority of experiments will be conducted in the dedicated taphonomy wet-lab involving dissection and photography. Microbial flora will be characterized using DNA and 16/18S rRNA sequencing. Decay specimens may also be assessed using 3D-tomography and the student will have access to world-class facilities in the Williamson Research Centre for Molecular Environmental Science for the analytical analyses. Palaeontological data will be incorporated through direct observation and analysis of fossil material. The student will therefore receive training in a range of analytical techniques. The project would suit students with a background in either geology or biology with some experience of palaeobiology. Additional experience in any of microbiology, comparative anatomy, geochemistry or sedimentology is also desirable, but not expected in combination.

References

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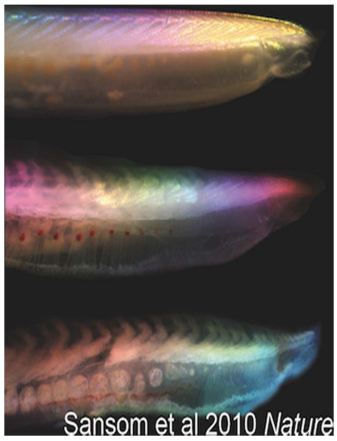

Image 1 – Sequences in the anatomical decay of the invertebrate chordate Amphioxus revealing the bias of 'stem-ward slippage' whereby organisms appear more primitive as they decay