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Livers, guts and gills: mapping the decay profiles of soft tissues to understand authigenic mineral replacement.

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The hard mineralised parts of organisms such as shells, teeth and bones dominate the fossil record. There are, however, sites around the world where soft-tissues are preserved often through rapid replacement of original tissue by rapidly-precipitating authigenic minerals. These exceptionally well-preserved soft-bodied fossils are much more informative about the anatomy, physiology, ecology and behaviour of ancient organisms as well as providing a more inclusive picture of ecosystems and evolution throughout geological time.

However, despite the wealth of information that soft-bodied fossils can provide they must first be correctly interpreted as the processes of both decay and preservation act to modify the carcass from its in vivo condition. Decay leads to alteration of the appearance and topology of anatomy, and ultimately to loss. Preservation is selective with some anatomical features being more likely to be captured than others. These problems are especially germane to the interpretation of deep-time and/or enigmatic fossils where no modern analogue exist for comparative anatomical analysis. It is therefore of vital importance to understand the processes carcasses undergo during the fossilisation process, , in order to interpret the anatomical remains of fossils and thus extract true evolutionary presence or absence of anatomy from absence due to taphonomic biases.

We have designed a series of novel experiments to investigate, in real time, how decay processes affect the fossilisation potential of soft-tissues – especially of internal anatomy. Our data allow us to unravel both the timing and sequence of anatomical decay of different organs. At the same time through measuring Eh and pH in selected organs we can predict when anatomical features will fall in to the window of authigenic mineralization and thus potentially become preserved. We can also place constraints on which minerals will operate to capture tissues. Our findings are applied to the fossil record allowing greater accuracy in reading the record of exceptionally preserved organisms.