THE ROLE OF MICROBES IN THE PRESERVATION OF PROTEROZOIC FOSSIL EUKARYOTES: EXPERIMENTAL APPROACHES. S. McMahon[1], L. Tarhan, R. P. Anderson & D. E. G. Briggs. Department of Geology and Geophysics, Yale University, 210 Whitney Avenue, New Haven, CT06511, USA. [1]sean.mcmahon@yale.edu.

Introduction: Rare assemblages of exceptionally well-preserved fossils ("Konservat-Lagerstätten") provide unique information about the diversification of complex life on Earth. However, the fidelity and integrity of this record varies according to the biological tissue type preserved, and the environmental setting, sediment characteristics, seawater chemistry and microbiological community present during decay and fossilization. With these variables in mind, we are conducting experiments to explore the origins of a range of exceptionally well-preserved Proterozoic fossils, with a particular focus on the enigmatic soft-bodied organisms of the Ediacaran and the organic-walled microorganisms of the Neoproterozoic.

Ediacaran "Death Masks": Important Konservat-Lagerstätten of the Ediacaran and early Palaeozoic yield molds and casts of large soft-bodied organisms in coarse-grained siliciclastic rocks ("Ediacara-style" preservation). Gehling's (1999) "Death Mask" model imputes these fossil surfaces to the early and rapid precipitation of Fe-S mineral cements generated by the sulfidogenic decay of associated microbial mats [1]. Building on previous work at Yale [2], our experiments aim to test this model and determine microbiological controls on this style of preservation.

Experimental approach. We are cultivating well-characterised, diverse saltwater microbial mats recovered from the salt marsh at Barn Island on the Connecticut coast. These mats are approximately one-centimetre thick and have cracked, pustular surfaces that resemble Proterozoic microbially induced sedimentary structures. They contain a redox-stratified assemblage of diatoms, cyanobacteria, purple sulfur bacteria, sulfate reducers and other organisms. We are burying sea anemones (e.g. *Nematostella*—chosen for its soft but clearly differentiated body) in sand with and without these mats and at varying concentrations of Fe(III), SO_4^{2-} and silica. Decay, mineralization and preservation will be monitored over several months. We will use resin impregnation and a variety of analytical techniques to trace the interactions between seawater chemistry, microbial activity, the biostabilization and cementation of sediment, and ultimately the chemical and morphological fidelity of fossil preservation. A better understanding of these processes may elucidate the opening and closing of the "Ediacara-style" taphonomic window in geological time.

Clay–Microbe Interactions: The presence and preservational quality of fossils correlates with clay mineral assemblages in some Proterozoic and later deposits. For example, in Cryogenian carbonates of the Taishir Formation in Mongolia, eukaryotic microfossils occur only in horizons in which the clay fraction is dominated by berthierine or talc, and are absent from those dominated by kaolinite. Direct interactions between tissues and clays have previously been suggested to affect preservational quality in the context of Burgess-Shale-type preservation in the Cambrian [3, 4]. We suggest that overlooked clay–microbe interactions could play critically important roles in preservational pathways. Such interactions are extensively documented and are thought to include the electrostatic adsorption of cells to mineral particles, the penetration of cells by crystals, the leaching of antimicrobial metal cations from clays, and the buffering of pH and Eh by clays [e.g. 5, 6. 7]. We are beginning an experimental search for the effects of clay–microbe interactions on tissue decay and preservational quality.

Experimental approach. We are culturing bacteria involved in marine animal decay and preservational pathways (e.g. *Pseudoalteromonas* and SO_4^{2-}-reducers) in marine nutrient media with and without suspensions of pure, well-characterised clays. Bacterial growth and metabolic activity will be tracked for each clay composition. Results will be compared with tissue preservational fidelity in the same clays, both in decay experiments *in vitro* and in the fossil record. Our results have the potential to reveal biases in the Neoproterozoic fossil record and to illuminate the controls on critical taphonomic pathways.

References: [1] Gehling J. G. (1999) *Palaios, 14,* 40–57. [2] Darroch S. A. F., LaFlamme M., Schiffbauer J. D. and Briggs D. E. G. (2012) *Palaios, 27,* 293–303. [3] Butterfield N. (1990) *Palaeobio., 16,* 272–286. [4] Wilson L. A. and Butterfield N. (2014) *Palaios, 29,* 145–153. [5] Wong D., Suflita J. M., McKinley J. P. and Krumholz L. R. (2004) *Microbial Ecol., 47,* 80–86. [6] Williams L. B. et al. (2011) *Env. Sci. Tech., 45,* 3768–3773. [7] Cai P., Huang Q. and Walker S. (2013) *Env. Sci. Tech., 47,* 1896–1903.