The economics of macromolecule degradation in the ocean - a microbial perspective

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Heterotrophic microbial communities process much of the organic matter in the ocean; they rework and respire components of sinking particles, and in sediments act as the final filter before organic matter is buried on geologic timescales. Despite the importance of the processes they carry out, our understanding of the tools and strategies microbes use to transform complex organic matter is still lacking. In particular, the economics of extracellular enzymes – the tools used to initiate processing of high molecular weight substrates – are incompletely understood. Ecological theory considers extracellular enzyme production via a cost-benefit analysis: investments of C, N, and energy into enzymes that are released into the environment must pay off, even though some of the resulting hydrolysate may be lost to scavenging bacteria. Our discovery that some marine bacteria use a 'selfish' uptake mechanism, in which a substrate is bound, initially hydrolyzed, and transported into the cell with little to no loss of hydrolysis products to the external environment, changes the terms of this equation. We recently found that selfish bacteria are active throughout the water column of the ocean, and especially in the bathypelagic, they process complex substrates that are otherwise not hydrolyzed. Selfish strategies clearly pay off under a wide range of environmental conditions, and should be included in our measurements and models of organic matter processing in the ocean.