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Pressure Effects on Microbial Enzymatic Activities Across Marine Environments

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Microbially-produced enzymes catalyze the first step of organic matter degradation, but the extent to which their activities are affected by high hydrostatic pressures (HP) that characterize much of the oceans remain little understood. Understanding the effect of HP on enzymatic activities is equally relevant to some shallow marine-derived microorganisms—including those that live associated with sinking particles or those that live in shallow sediments that seed deep-sea environments by down-slope dispersal. Using a recently developed rotating pressure chamber, we quantified the effect of increasing levels of HP on the enzymatic activities of several microbial communities from coastal surface waters and sediments, and communities associated with copepod and phytoplankton cultures. Enzymatic activities assayed include leucine aminopeptidase, β-glucosidase, chitinase, laminarinase, pullulanase, xylanase, and chondroitin hydrolase. Rates were simultaneously measured at HP and ambient/atmospheric pressure (AP), the ratio of which signifies the pressure effect (PE = $Rate_{HP}/Rate_{AP}$). We tested the following hypotheses: 1) PE would vary widely across different enzymes, and 2) PE < 1 for microbial communities sourced from shallow environments, indicating pressure-sensitivity. We measured varying PE for different enzymes, but values were generally < 1. However, low-to-moderate levels of HP do not lead to complete inhibition for a subset of enzymatic activities, suggesting differing degrees of pressure tolerance among surface-derived microbial communities. Future studies will examine enzymatic activities of HP-adapted microbial communities, which are more likely to yield values of PE > 1. Systematic and widespread measurements of PE could provide insight into whether enzymatic activities from diverse marine environments, most commonly measured at AP, are likely over- or underestimates of their rates at *in situ* HP. Overall, these results suggest that increasing pressure likely acts as a selective force for sinking microbial communities, dampening the rates at which they can degrade specific components of sinking organic matter. Through its effect on microbial enzymatic activities, pressure may influence the quantity and quality of surface-derived organic matter that reach great oceanic depths.