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Characterization and microbial degradation of polysaccharides in high molecular weight dissolved organic matter.

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A large fraction of marine primary production is directed towards the synthesis of polysaccharides, most of which are rapidly degraded by heterotrophs, including heterotrophic microbes. However, a novel class of polysaccharides characterized by high N-acetyl aminosugar and 6-deoxysugar content, escapes rapid degradation and accumulates as a constituent of marine dissolved organic matter (DOM). These polysaccharides, which comprise ~25% of total dissolved organic carbon, also represent a large reservoir of the potentially bioavailable organic N and P stored in DOM. To better understand the accumulation and microbial degradation of DOM polysaccharides we used size-exclusion chromatography and diffusion-ordered NMR spectroscopy to examine the size-distribution and composition of DOM recovered from seawater by ultrafiltration. Our results show that DOM polysaccharides are relatively small, with a molecular weight range of 1.3–7.7 kD and an average molecular weight of ~6 kD in surface waters decreasing to ~3 kD at 900m. Acid hydrolysis of DOM polysaccharides releases a suite of characteristic neutral sugars (glucose, galactose, mannose, rhamnose, fucose and xylose), but most of the polysaccharide (80-90%) resists hydrolysis and undergoes Maillard-like reactions between amino- and reducing sugars. To circumvent this, we modified our hydrolysis conditions to promote sugar-sugar cleavage. With this approach, we were able to generate a suite of oligosaccharides with molecular weights between 0.3-1.8 kD that carry the same spectral characteristics as DOM polysaccharides. We are using transposon insertion sequencing (Tn-seq) of marine bacteria cultured on these oligosaccharides to identify genes and degradation pathways responsible for DOM polysaccharide degradation.