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TITLE: Biological composition and microbial dynamics of sinking particulate organic matter at abyssal depths in the oligotrophic open ocean

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ABSTRACT:

Sinking particles are a critical conduit for the export of organic material from surface waters to the deep ocean. Despite their importance in oceanic carbon cycling and export, little is known about the biotic composition, origins, and variability of sinking particles reaching abyssal depths. Here, we analyzed particle-associated nucleic acids captured and preserved in sediment traps at 4,000-m depth in the North Pacific Subtropical Gyre. Over the 9-month time-series, Bacteria dominated both the rRNA-gene and rRNA pools, followed by eukaryotes (protists and animals) and trace amounts of Archaea. Deep-sea piezophile-like Gammaproteobacteria, along with Epsilonproteobacteria, comprised >80% of the bacterial inventory. Protists (mostly Rhizaria, Syndinales, and ciliates) and metazoa (predominantly pelagic mollusks and cnidarians) were the most common sinking particle-associated eukaryotes. Some near-surface water-derived eukaryotes, especially Foraminifera, Radiolaria, and pteropods, varied greatly in their abundance patterns, presumably due to sporadic export events. The dominance of piezophile-like Gammaproteobacteria and Epsilonproteobacteria, along with the prevalence of their nitrogen cycling-associated gene transcripts, suggested a central role for these bacteria in the mineralization and biogeochemical transformation of sinking particulate organic matter in the deep ocean. Our data also reflected several different modes of particle export dynamics, including summer export, more stochastic inputs from the upper water column by protists and pteropods, and contributions from sinking mid- and deep-water organisms. In total, our observations revealed the variable and heterogeneous biological origins and microbial activities of sinking particles that connect their downward transport, transformation, and degradation to deep-sea biogeochemical processes.

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