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Lugworm bioturbation controls microbial abundance, activity, and community assembly and biogeochemical cycles in intertidal sediments

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Intertidal sediments are globally important ecosystems with rapid biogeochemical cycling of carbon, sulfur, and nitrogen. Yet, an understanding of how the diverse intertidal macro- and microbial life interact and drive these biogeochemical cycles remains limited. Here we explore the impact of bioturbation activities by lugworms (*Abarenicola pacifica*) on microbiological community structure and elemental cycles in intertidal sediments of False Bay, USA. To this end, we performed 5-week-long time-series sampling of sediments with and without lugworm bioturbation, and carried out parallel lugworm exclusion and recolonization experiments.

Geochemical profiling and modeling reveal strong impacts of lugworm bioirrigation on porewater chemistry, in particular redox conditions, in surface sediment. Despite this strong biogeochemical impact of bioirrigation, microbial communities are highly similar across bioirrigated and non-bioirrigated surface sediments, and are dominated by functionally diverse facultative aerobes and anaerobes. In contrast, the reworking activities of lugworms strongly reduce bacterial and archaeal abundances and result in distinct microbial community compositions in subsurface layers (15-25 cm). We postulate that this strong impact of reworking is related to selective deposit feeding by lugworms on small sedimentary particles that are enriched in fresh algal detritus. This selective feeding also produces graded bedding with coarser sands and refractory organic carbons dominating these subsurface layers. Remarkably, with the exception of a small core community of diverse *Alphaproteobacteria*, *Bacteroidetes*, and *Saccharibacteria*, lugworm bioturbation eliminates the strong co-occurrence correlations among microbial taxa that are present in adjacent non-bioturbated sediment.

Our approach, which integrates field-based research on macrofaunal behavior, biogeochemical processes, and microbial community compositions, shows that reworking activity by large macroinvertebrates has a profound impact on microbial activities and community structure in intertidal sediments. In this regard, bioturbation not only affects the distributions of physiologically divergent microbial lineages, but also fundamentally alters the structure and connectivity of microbial food webs in these ecosystems.