Direct and indirect effects of macrofaunal functional diversity and bacterial and archaeal community characteristics determine benthic nitrogen cycling in coastal marine sediments

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Nitrogen (N) is most often implicated as the nutrient limiting primary production in the coastal ocean. Sediments are important sites for N cycling in coastal ecosystems.
Nearly half of the produced primary production is eventually deposited onto the shallow continental shelf seafloor, where benthic activities (bioturbation, bio-irrigation) play a fundamental role in the recycling of nutrients needed by primary producers back into the water column.
However, it is well-known that the nutrient cycle is resulting from the activity of microorganisms (bacteria and archaea). Hence, the activity of macrofauna has an indirect effect on benthic nutrient cycling through its direct effect on microbial communities.

Recent studies have shown that macrofaunal functional diversity indeed affects the structure and activity of benthic microbial communities in experimental settings. However, field studies, linking macrofaunal functional diversity, microbial diversity and nutrient cycling have not been conducted so far. Here, we report on such an attempt from shallow North Sea sediments.
We sampled for macrofauna, bacteria and archaea in general, and ammonia oxidising bacteria (AOB) and archaea (AOA) in detail, in 7 sampling stations covering various sediment types (muddy, fine sandy and permeable) during the peak spring bloom (April), shortly after mass sedimentation (June) and during the period of highest benthic mineralisation rates (September).

Measured nitrification rates were highest in September, where they coincide with high benthic bioturbation activity especially in fine sediments and the highest OTU richness of bacterial and archaeal nitrifying communities (AOB and AOA).
Macrofauna effects were indeed affecting the diversity of nitrifying organisms (AOB and AOA), and the general bacterial community.

Furthermore, together with some sedimentary abiotic variables, biotic variables, including spatial and seasonal changes in the Bioturbational Potential of macrofaunal Communities (BPc) and richness or diversity of bacteria significantly affected denitrification rates and the overall sediment N-mineralization.

Our results thus reveal that the presence and functional diversity of macrofaunal communities indeed affects benthic mineralisation processes in field situations by affecting the biogeochemical properties of the sediment and hence the diversity of the microbial communities active in these processes.