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Mat-forming sulfide-oxidizing bacteria thriving in the hypoxic zone of the Crimean shelf (Black Sea)

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The structure and function of benthic communities strongly depends on the availability of oxygen. The Black Sea is naturally depleted in oxygen below 100 to 150 m water depth and thus represents an ideal natural laboratory to investigate effects of different oxygen conditions on benthic microbial processes. In April/May 2010 the shelf area northwest of Crimea was visited during the research cruise MSM 15/1 with the German R/V MARIA S. MERIAN as part of the EU project HYPOX. Biological, chemical, and geological parameters were studied in the water column, at the seafloor, and in the sediment. Deployments of several autonomous instruments and remotely operated platforms for different periods of time were combined with intense seafloor monitoring to resolve the spatial and temporal variation in oxygen concentration and its effect on life on the Crimean shelf. Additionally, ex-situ sulfide microsensor measurements were conducted in the laboratory on retrieved sediment cores.
Oxygen measurements performed at different sites on a 25 mile long transect spanning from 100 to 400 m water depth showed strong temporal fluctuations with concentrations changing between 0-150 μmol L-1 within one day. At 150-170 m water depth and oxygen concentrations ranging from 0 to about 30 μmol L-1 large filamentous sulfide oxidizing bacteria were found to have established bacterial mats on top of patchy accumulations of detritus particles of >6 cm thickness. Below the mats steep pore water sulfide gradients were found indicating a production of 200-600 μmol sulfide L-1 in the near-surface sediment. Morphologically, the mat-forming bacteria resembled Beggiatoa, well-known giant sulfur-oxidizing bacteria often found where sulfide is present close to the oxygenated seafloor. The filaments were of variable diameter and the internally stored, white sulfur globules were clearly visible under the microscope. The formation of these bacterial mats on top of the sediment could also be stimulated in cores from an hyoxic station at 155 m water depth by gradually decreasing the oxygen concentration in the overlaying water over several hours. This process was documented by time-lapse imaging of the sediment surface together with continuous oxygen concentration measurements in the water.
The study shows that in this part of the Crimean shelf the high accumulation of labile organic matter creates favorable conditions for sulfide production, high enough for Beggiatoa colonies to form dense microbial mats. Interestingly, these appear to resist temporary anoxia, actively follow the chemical gradients and thus seem well adapted to this highly variable environment.