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Photosynthetic activity and community structure in intertidal microbial mats revealed by taxon-specific rRNA SIP method

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Microbial mats are a multi-layer of diverse benthic microorganisms, commonly dominated by photosynthetic bacteria. Those in marine intertidal flats often experience strong fluctuation of oxygen/sulfide concentrations, hence may serve as a modern model system for the study of organismic response to the redox shift in the past. Here we integrated stable isotope probing (SIP) and magnetic-bead capture hybridization and assessed diversity and physiology in coastal microbial mats, with special focus on how cyanobacteria respond to redox change in the environment.

Microbial mats were sampled from two locations, distinct in position along the littoral gradient, in the sandy beach facing the North Sea in the Dutch barrier island Schiermonnikoog in summers of two successive years. In order to investigate effects of the environmental factors on photosynthetic activity, the collected mats were incubated with [^{13}C]sodium bicarbonate under varied oxygen/sulfide conditions in a temperature- and light-controlled room, and were freeze-stored until total RNA extraction. Taxon-specific rRNAs were captured using magnetic beads with biotin-modified probes and analyzed for molecular phylogeny and for ^{13}C labeling, to directly link taxonimic diversity and physiological property of active microbes under each tested condition.

Analysis of 16S rRNA clone libraries confirmed high taxon specificity of the oligonucleotide probes used in this study. The phylogenetic study showed that the microbial mats from both sampling sites were predominated by cyanobacteria, most of which were non-heterocystous filamentous species (Oscillatoriales), with minor fraction of coccoid (Chroococcales) and heterocystous ones (Nostocales). Although the oscillatorialean *Microcoleus* occupied a major part in both, the two sites presented marked difference in responce to the growth conditions as well as in overall taxonomic diversity. Continuing study of microbial communities together with detailed investigation of isolate cultures, will provide us a clue to a better understanding of not only ecological characteristics of photoautotrophs, but also their evolutionary background in the earth's changing environments.

Keywords: cyanobacteria, redox condition, 16S rRNA, stable isotope, diversity, microbial mats