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A single cell nanoSIMS view on the transfer of fixed nitrogen to bacteria associated with filamentous N-fixing cyanobacteria in the Baltic Sea

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The large filamentous cyanobacteria *Aphanizomenon* sp., *Anabaena* sp. and *Nodularia* sp. are the three main nitrogen fixers in the Baltic Sea. These species form massive blooms in the photic zone during summer, gaining the energy required for nitrogen fixation through photosynthesis. Atmospheric dinitrogen is fixed in specialized cells, the so-called heterocysts, and is rapidly transferred to the vegetative cells. Previous studies have reported, that attached and free living microorganisms profit from the release of nutrients by the cyanobacteria. However, up to now the transfer of fixed nitrogen from cyanobacterial cells to the associated microorganisms has not been directly shown in the environment. In this study we used a combination of stable isotope incubations, isotope ratio mass spectrometry and nanoscale secondary ion mass spectrometry (nanoSIMS) to measure N and C-uptake by single microbial cells associated with blooming cyanobacteria. By using Halogen *in-situ* hybridization coupled to nano-scale secondary ion mass spectrometry (HISH-SIMS) we identified the epibionts and the freeliving bacteria and at the same time measured their nitrogen and carbon uptake rates. We show that the community of organisms profiting from nutrient N and C release is dominated by bacterial members of the Alphaproteobacteria, Gammaproteobacteria and Cytophaga as well as single celled eukaryotes. These results show for the first time at a single cell level that fixed nitrogen and carbon are rapidly transfered to the microbial community in the Baltic Sea.