

Diatom-bacteria interactions in marine intertidal biofilms: nature, constraints and specificity

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Since their origin, diatoms have shared their habitats with bacteria. It is becoming increasingly clear that this has resulted in the coevolution of often highly specific interactions, ranging from antagonistic to symbiotic. Especially in biofilms, interactions are assumed to be intimate and intense. However, little is known about the exact nature of these interactions, what biological and environmental factors constrain them, and how specific they are. In order to better understand the importance of diatom-bacteria interactions, we studied associations and interactions between bacteria and intertidal benthic diatom species, with a focus on the species complex around *Cylindrotheca closterium*. While our experiments show that different diatom species harbour distinct bacterial communities, we found no evidence for clade-specificity within the *C. closterium* species complex. Instead, amplicon sequencing revealed a strong environmental and geographic signal in the associated bacterial communities of about 80 *C. closterium* strains from various tidal flats in The Netherlands, Belgium and Northern France. Diatom competition experiments with and without bacteria showed that bacteria altered the outcome of competitive interactions and as a result biofilm species composition. Diatom-bacteria co-culture experiments evidenced both antagonistic and synergistic effects of bacteria on *C. closterium* strains. Apart from effects of the bacteria on diatom fitness, the bacteria also caused remarkable behavioural changes in growth form and aggregation patterns in the diatoms. Positive effects on diatom growth were especially pronounced under nutrient-limited conditions. Several *Marinobacter* strains strongly inhibited diatom growth, but this effect did not always persist and could vary even between different isolates from the same *Marinobacter* strain. Whole-genome comparisons between an inhibitory *Marinobacter* and closely related *Marinobacter* strains revealed pronounced interspecific differences in sequences coding for mobilome elements such as plasmids and transposons, suggesting that these could be involved in the inhibitory effect on diatom growth, and offering a potential explanation for the loss of this antagonistic effect in some strains. Ongoing research is now focusing on diatom-bacteria signalling mechanisms, and the use of transcriptomics and metabolomics to uncover the genes and pathways underlying the observed interactions.