Small-scale shear effects on heterocystous cyanobacteria

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ABSTRACT: Planktonic, filamentous, heterocystous cyanobacteria form blooms in certain nitrogen-limited ecosystems but are absent or rare in others that seem to have suitable environmental conditions. We tested the hypothesis that small scale shear affects physiological activities and morphology of heterocystous cyanobacteria in high turbulence environments. Using Taylor-Couette flow to generate small-scale shear, we conducted one set of experiments on cultures of two strains of Baltic Sea *Nodularia* and a complementary set of experiments using natural Baltic Sea phytoplankton assemblages. Experiments were run at various shear durations (1-72 h) and levels (2.2-18 s^{-1}), corresponding to energy dissipation rates in the upper mixed layer from moderate to strong winds. The effect of shear on nitrogenase activity (NA), CO_2 fixation, pH, dissolved inorganic carbon, and cyanobacterial filament length was tested. Results from the culture experiments showed that shear had a negative effect on NA and CO_2 fixation for both *Nodularia* strains and that filament length decreased for one of them. The lower limit for shear effects on NA and CO_2 fixation appeared to be less than 2.2 s^{-1}. Results from the experiments on natural phytoplankton assemblages from the Baltic Sea showed that both CO_2 fixation (reflecting cyanobacterial photosynthetic activity) and NA decreased in response to shear. However, shear did not affect CO_2 fixation in the <2-μm size fraction. *Aphanizomenon* and *Anabaena* filaments fragmented under shear rates (2.2 s^{-1}, 12 h) that did not affect *Nodularia* filament length. These results suggest that small-scale shear imposes a control on cyanobacterial activity and morphology and that this control appears to be genus and species specific.