Influence of water-column depth and mixing on phytoplankton biomass, community composition, and nutrients

Jäger, Christoph G., Sebastian Diehl, Gertraud M. Schmidt

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ABSTRACT: We independently manipulated mixing intensity (strong artificial mixing vs. background turbulence) and water-column depth (2 m, 4 m, 8 m, and 12 m) in order to explore their separate and combined effects in a field enclosure experiment. To accentuate the vertical light gradient, enclosures had black walls, resulting in a euphotic depth of only 3.7 m. All enclosures were placed in a well-mixed water bath to equalize temperature across treatments. Phytoplankton responded to an initial phosphorus pulse with a transient increase in biomass, which was highest in the shallowest, least light-limited water columns where dissolved mineral phosphorus subsequently became strongly limiting. As a consequence, the depth-averaged mineral phosphorus concentration increased and the seston carbon (C) : phosphorous (P) ratio decreased with increasing water-column depth. Low turbulence enclosures became quickly dominated by motile taxa (flagellates) in the upper water column, whereas mixed enclosures became gradually dominated by pennate diatoms, which resulted in higher average sedimentation rates in the mixed enclosures over the 35-d experimental period. Low turbulence enclosures showed pronounced vertical structure in water columns >4 m, where diversity was higher than in mixed enclosures, suggesting vertical niche partitioning. This interpretation is supported by a primary production assay, where phytoplankton originating from different water depths in low-turbulence treatments had the relatively highest primary productivity when incubated at their respective depths of origin.

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