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Factors influencing the initiation of blooms of the raphidophyte Heterosigma akashiwo and the diatom Skeletonema costatum in a port in Japan

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ABSTRACT: We investigated how environmental factors initiate *Heterosigma akashiwo* and *Skeletonema costatum* blooms from resting stages in bottom sediments in a shallow port over 2 yr. Using field-collected sediments, we also conducted laboratory experiments on how light intensity affects germination of resting stages and growth of the germinated cells. Both phytoplankton species bloomed only in summer, when water temperature and solar radiation were high enough for growth. All three blooms of *H. akashiwo* and the earliest bloom of *S. costatum* in a year occurred right after transmission of strong light (>200 µmol quanta m^{-2} s^{-1}) to the bottom layer and a peak occurred in dissolved inorganic phosphorus (DIP). In the laboratory, resting stages of *H. akashiwo* and *S. costatum* germinated even in dim light (20 and 65 µmol quanta m^{-2} s^{-1}, respectively), but germinated cells required stronger light of >130 and 280 µmol quanta m^{-2} s^{-1}, respectively, for rapid growth. This value is much higher than the threshold for survival, and is higher than the half-saturating light intensity for growth of vegetative cells. Abundance of the resting stages of both species in the sediments rapidly increased during blooms and logarithmically decreased during nonbloom periods, suggesting that resting stages are continuously consumed. For both species, our results suggest that blooms initiate when transmission of sufficient light permits: first, germination of cells from the sediment; second, rapid growth of these germinated cells. Temperature and DIP must also exceed a facilitating threshold.

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