Quantifying diatom aspirations: Mechanical properties of chain-forming species

A. M. Young, L. Karp-Boss, P. A. Jumars and E. N. Landis

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ABSTRACT: Diatoms developed a variety of mechanisms to form chain-like colonies, resulting in diverse morphologies and bulk mechanical properties. These properties affect translation, rotation, and deformation of colonies in ambient flows as well as their susceptibility to breakage by flow- and grazer-induced forces. Morphological characteristics of diatom chains have been extensively studied, yet no studies have examined their mechanical properties. We studied the flexibility of four morphologically distinct species (*Lithodesmium undulatum*, *Stephanopyxis turris*, *Lauderia annulata*, and *Guinardia delicatula*) by measuring their deflections when held across a capillary tip in developing pipe flow and applying simple beam theory and a finite-difference analysis of curvature to calculate flexural stiffness. Flexural stiffness varies greatly, with at least four orders of magnitude difference among the examined species (from 1.7×10^{-13} N m^2, the most rigid, to 1.3×10^{-17} N m^2, the most flexible), but two other species (*Melosira nummuloides* and a *Thalassiosira* sp.) were too flexible to measure with our apparatus. Vulnerability to breakage by flow also varied between species and, for species with heavily silicified joints between cells, was enhanced under nutrient depletion. These results highlight yet another attribute underlying the biodiversity of diatoms and their potential for utilizing highly differentiated ecological niches. Quantitative information from this study can now be used in the design of more mechanically realistic models that capture the dynamic coupling between elastic particles and flow to study diatom – flow interactions and their effects on nutrient acquisition, encounter with grazers, aggregate formation, and settling.

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