A size-structured food-web model for the global ocean

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ABSTRACT: We present a model of diverse phytoplankton and zooplankton populations embedded in a global ocean circulation model. Physiological and ecological traits of the organisms are constrained by relationships with cell size. The model qualitatively reproduces global distributions of nutrients, biomass, and primary productivity, and captures the power-law relationship between cell size and numerical density, which has realistic slopes of between −1.3 and −0.8. We use the model to explore the global structure of marine ecosystems, highlighting the importance of both nutrient and grazer controls. The model suggests that zooplankton : phytoplankton (Z : P) biomass ratios may vary from an order of 0.1 in the oligotrophic gyres to an order of 10 in upwelling and high-latitude regions. Global estimates of the strength of bottom-up and top-down controls within plankton size classes suggest that these large-scale gradients in Z : P ratios are driven by a shift from strong bottom-up, nutrient limitation in the oligotrophic gyres to the dominance of top-down, grazing controls in more productive regions.

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