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Dynamics of plankton populations in pelagic ecosystem: An in silico study

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Abstract

Aquatic ecologists are puzzled to explain the variety of dynamics shown by planktonic ecosystem. Explaining phytoplankton bloom phenomenon (increase in phytoplankton abundance) is a fascinating issue both for the theoreticians and experimentalists. Various explanations have been given for the occurrence and nonoccurrence of monospecies and multispecies planktonic bloom. Still the issue remains controversial and partially understood. Sometimes different experiments on phytoplankton zooplankton interaction show contradictory results. For example, some experiments show that phytoplankton-zooplankton interaction is lost and populations become prone to extinction through high amplitude oscillations with increasing supply of nutrient (paradox of enrichment). In contrary, some experiments report that the Daphnia-algae (predator-prey) interaction does not show any nutrient-enriched cycle. Based on different observations, we propose a phytoplankton-zooplankton (prey-predator) model that incorporates zooplankton's selectivity and phytoplankton's nutritional effects in an explicit way and reveal the planktonic dynamics. Our study demonstrates that phytoplankton-zooplankton interaction in pelagic ecosystem is very complicated and the system dynamics, including bloom phenomenon, strongly depends on the selective predation of zooplankton and the nutritional value of phytoplankton. Our study supports some existing hypothesis like decoupling at plant-animal interface may occur due to strong fish predation on zooplankton. In addition, we show that decoupling of food chain may also occur under low to intermediate nutrient inflow if zooplankton feeds on phytoplankton having lower nutritional value. We also demonstrate that paradox of enrichment is unlikely to occur if predator feeds on low nutritious prey and most likely to occur if predator preferentially consumes high nutritious prey.