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Phytoplankton diversity affects biomass and energy production differently during community development

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Abstract:

1. Biodiversity determines the productivity and stability of ecosystems but some aspects of biodiversity–ecosystem functioning relationships remain poorly resolved. One key uncertainty is the inter-relationship between biodiversity, energy and biomass production as communities develop over time. Energy production drives biomass accumulation but the ratio of the two processes can change during community development. How biodiversity affects these temporal patterns remains unknown.
2. We empirically assessed how species diversity mediates the rates of increase and maximum values of biomass and net energy production in experimental phytoplankton communities over 10 days in the laboratory. We used five phytoplankton species to assemble three levels of diversity (monocultures, bicultures and communities) and we quantify their changes in biomass production and energy fluxes (energy produced by photosynthesis, consumed by metabolism, and net energy production as their difference) as the cultures move from a low density, low competition system to a high density, high competition system.
3. We find that species diversity affects both biomass and energy fluxes but in different ways. Diverse communities produce net energy and biomass at faster rates, reaching greater maximum biomass but with no difference in maximum net energy production. Bounds on net energy production seem stronger than those on biomass because competition limits energy fluxes as biomass accumulates over time.
4. In summary, diversity initially enhances productivity by diffusing competitive interactions but metabolic density dependence reduces these positive effects as biomass accumulates in older communities. By showing how biodiversity affects both biomass and energy fluxes during community development, our results demonstrate a mechanism that underlies positive biodiversity effects and offer a framework for comparing biodiversity effects across systems at different stages of development and disturbance regimes.

Keywords: biodiversity-ecosystem functioning, competition, ecosystem functioning, metabolism, species turnover