Microbial metabolic diversity and ecosystem functioning in simulated model

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Calacterization of the relationship between biodiversity and ecosystem functioning has been one of the central issues in ecology for the last two decades. Ecosystem function is defined as the capacity of natural processes resulting from complex interactions between abiotic and biotic components responsible for biogeochemical reactions. Primary production or respiration rate, the major carbon flow in ecosystems, is typically used as the representative of ecosystem functioning, whereas diverse microbial metabolic pathways drive not only major but minor element cycles. The diversity of microbial metabolic types may increase the overall fluxes of energy or material processing, although it is laborious to identify and quantify all processes going on in ecosystems.

In this study, we present a conceptual simulation model in which microbial community composed of defferent metabolic groups harness energy from arbitrarily given set of redox reactions in an artificial oxic-anoxic interface. There is a continuous flow of liquid medium which supplys this interface with electron donors and acceptors. Energetically favorable redox reactions only take place, and specific metabolic groups mediate the reactions to obtain energy. The population dynamics of metabolic groups are only constrained by energy supply, which is calculated based on the thermodynamics and kinetics. The model was simulated with various environmental settings to explore the relationship between microbial metabolic diversity and the overall material flux in the interface.

Compared to the abiotic conditions, the presence of microbial community increased the overall material fluxes. A strong correlation was found between total biomass of microbial community and overall material fluxes, but not between the diversity of survived metabolic groups and overall material fluxes. However, syntrophic relationships increased material fluxes and promotes coexistence.