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Microbes as Engines of Ecosystem Function: When Does Community Structure Enhance Predictions of Ecosystem Processes?

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ABSTRACT

Microorganisms are vital in mediating the earth's biogeochemical cycles; yet, despite our rapidly increasing ability to explore complex environmental microbial communities, the relationship between microbial community structure and ecosystem processes remains poorly understood. Here, we address a fundamental and unanswered question in microbial ecology: 'When do we need to understand microbial community structure to accurately predict function?' We present a statistical analysis investigating the value of environmental data and microbial community structure independently and in combination for explaining rates of carbon and nitrogen cycling processes within 82 global datasets. Environmental variables were the strongest predictors of process rates but left 44% of variation unexplained on average, suggesting the potential for microbial data to increase model accuracy. Although only 29% of our datasets were significantly improved by adding information on microbial community structure, we observed improvement in models of processes mediated by narrow phylogenetic guilds via functional gene data, and conversely, improvement in models of facultative microbial processes via community diversity metrics. Our results also suggest that microbial diversity can strengthen predictions of respiration rates beyond microbial biomass parameters, as 53% of models were improved by incorporating both sets of predictors compared to 35% by microbial biomass alone. Our analysis represents the first comprehensive analysis of research examining links between microbial community structure and ecosystem function. Taken together, our results indicate that a greater understanding of microbial communities informed by ecological principles may enhance our ability to predict ecosystem process rates relative to assessments based on environmental variables and microbial physiology.

Full Text

http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/915_MicrobesEnginesEcosystemFunction.pdf