Emergence of the ecological strategies of soil microbes through eco-evolutionary dynamics, insight from a trait-based model

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Résumé

Soil microbes are important drivers of carbon and nutrient fluxes in terrestrial ecosystems through their strong contribution to organic matter decomposition and nutrient cycling. These ecological processes are supported by a large diversity of microbes with a wide range of life history traits. For example, fast-growing microbes (-r strategy) take up labile carbon, immobilise nutrients in their biomass and stabilise soil carbon in their necromass, whereas slow-growing microbes (-K strategies) decompose recalcitrant organic matter and recycle the nutrients stored in the soil. Other strategies have been proposed and their classification according to functional traits is still under debate. Recent metagenomic studies have shed light on the combination of traits that characterise microbial communities depending on their environment, but the functional groups forming such communities remain hypothetical. We propose a trait-based and spatially explicit model of microbial communities, including evolution, to explore the emergence of ecological strategies and identify the main microbial functional groups involved in soil ecosystem processes. In particular, we considered three main trade-offs that link traits and constrain ecological strategies: the energetic expenditure of physiological processes, the allocation of biomass to cell functions and the stoichiometry of cell components. We ran numerical simulations over gradients of litter quality (*i.e.* lignin content) and stoichiometry (*i.e.* nitrogen and phosphorus content), identified the functional groups that evolved in response to these environmental constraints and mapped them according to existing classifications. Our model allowed us to understand how the adaptation of microbes to their very local conditions shapes biogeochemical cycles at the ecosystem scale.

Mots-Clés: soil microbes, biogeochemical cycles, evolution, theoretical ecology, soil organic matter, nutrient cycling, trait, functional groups

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