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The role of microbial diversity in the dynamics and stability of global methane consumption: microbial methane oxidation as a model-system for microbial ecology (ESF EuroDiversity METHECO)

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Ecosystems collectively determine biogeochemical processes that regulate the Earth System. Loss of biodiversity is detrimental to ecosystems and therefore has been a central issue for environmental scientists. Although microorganisms form a major part of the Earth's biomass and biodiversity, and have a critical role in biogeochemistry and ecosystem functioning, they do not feature highly in ongoing debates about global biodiversity loss, global change and conservations issues. The neglect of microbial diversity in conservation issues is because microbial communities are regarded as being highly redundant, omnipresent, and therefore inextinguishable. This, however, is a misconception. Recently, the application of advanced molecular techniques has indicated that microbial communities display habitat preferences and are not universally distributed. Even the highly diverse microbial communities in soils can be affected by agricultural use, indicating that genetic erosion may potentially affect these communities as well. Moreover, many important environmental functions are catalyzed by specific groups of microbes with a very narrow ecological range. Recovery of these functional microbial communities after disturbance may take decades. Even if the species making up the community do not become extinct and eventually re-colonize an environment, the function and service to the biosphere is lost long enough to exert permanent, irreversible damage to the environment. Considering the global importance of microbes, combined with our ignorance of how the composition and functioning of these communities is affected, necessitates the assessment of the vulnerability and the resilience of microbial diversity. The latter is a pressing concern in biodiversity research and conservation policy, urgently needing attention in order to be able to anticipate environmental challenges we are facing. Our general hypothesis is: microbial diversity is linked to important ecosystem services and therefore cannot be ignored in nature conservation and management issues. Investigating this hypothesis is equivalent to assessing the Biodiversity-Ecosystem Functioning relationship (BEF) which has been intensively studied in classical ecology has largely been ignored investigating microbial communities. METHECO is focusing on methane oxidizing bacteria, a well-defined yet sufficiently diverse group of bacteria catalyzing an important ecosystem service: next to carbon dioxide, methane is the most important greenhouse gas adding about 30% to the radiative forcing exerted by carbon dioxide. The emission of methane would be even much higher without the activity of methane-oxidizing bacteria which on a global basis mitigate about 50% of the biologically produced methane. In contrast, methanotrophs in aerated upland soils form the only biological sink for atmospheric methane playing a vital role in the global climate. METHECO is studying diversity and functioning of methanotrophs over a wide range of European ecosystems from the Mediterranean to the Arctic, and from landfills to pristine environments. Our objectives are (i) the definition of meaningful taxonomic units which describe microbial diversity in the habitats studied, (ii) assessing the effects of perturbations on diversity and functioning, (iii) identifying controls of methanotrophic activity and diversity, and (iv) developing a standardized methodology and framework for environmental microbial ecology.