Predictive models of abundance and diversity of soil microbial communities

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Assessing soil biodiversity and role in ecosystem services

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Predictive models of abundance and diversity of soil microbial communities

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Soil over-exploitation for the development of intensive agriculture and industrialization has led to a significant erosion of biodiversity. Given the importance of soil biota for the delivery of many of the ecosystemic services, it becomes crucial to provide indicators and standards to soil users allowing them assessing soil biological quality and quantifying the impact of human activities. Among soil organisms, microorganisms (bacteria and fungi) are the most important in terms of density (10^6-10^9 individuals/g soil), diversity (10^3-10^6 species/g soil), and involvement in soil functioning. Consequently, the biological status of the soil depends closely on the properties of the indigenous microbial communities. Microbial indicators (density, diversity, activity) have been developed and standardized from the research conducted in environmental microbiology and they must now be transferred and made operational. To date, one missing step to develop soil biological diagnostic is the establishment of the standards needed for the robust interpretation of these bioindicators.

With this goal, we developed a mathematical strategy to provide the standards for the interpretation of microbial abundance (i.e. molecular microbial biomass) and diversity (i.e. richness and evenness), which are two of the most recognized indicators of soil quality. For this, we exploited the thousands microbial and environmental data obtained from the French Soil Quality Monitoring Network (RMQS), which covers the whole environmental variability of French territory to develop a predictive model of microbial bioindicators according to soil pedo-climatic conditions.

Technically, we developed statistical polynomial models to predict the natural range of variations of soil molecular microbial biomass and diversity. These models are innovative tools providing optimal value of microbial biomass and diversity for a given pedoclimatic condition, which must be compared with measured data to allow a robust diagnostic of soil quality. On the other hand, these models may provide more cognitive insights by their ability to evaluate the response of microbial community to pedoclimatic variations.

Keywords: Soil microbial communities abundance, Soil microbial diversity, Predictive models, Natural ranges of variation