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Using growth-based methods to determine direct effects of salinity on soil microbial communities

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Soil salinization is a widespread agricultural problem and increasing salt concentrations in soils have been found to be correlated with decreased microbial activity. A central challenge in microbial ecology is to link environmental factors, such as salinity, to responses in the soil microbial community. That is, it can be difficult to distinguish direct from indirect effects. In order to determine direct salinity effects on the community we employed the ecotoxicological concept of Pollution-Induced Community Tolerance (PICT). This concept is built on the assumption that if salinity had an ecologically relevant effect on the community, it should have selected for more tolerant species and strains, resulting in an overall higher community tolerance to salt in communities from saline soils. Growth-based measures, such as the 3H-leucine incorporation into bacterial protein , provide sensitive tools to estimate community tolerance. They can also provide high temporal resolution in tracking changes in tolerance over time.
In our study we used growth-based methods to investigate: i) at what levels of salt exposure and over which time scales salt tolerance can be induced in a non-saline soil, and (ii) if communities from high salinity sites have higher tolerance to salt exposure along natural salinity gradients.
In the first part of the study, we exposed a non-saline soil to a range of salinities and monitored the development of community tolerance over time. We found that community tolerance to intermediate salinities up to around 30 mg NaCl per g soil can be induced at relatively short time scales of a few days, providing evidence that microbial communities can adapt rapidly to changes in environmental conditions.
In the second part of the study we used soil samples originating from natural salinity gradients encompassing a wide range of salinity levels, with electrical conductivities ranging from 0.1 dS/m to >10 dS/m. We assessed community tolerance to salt by measuring the bacterial growth response to added NaCl in a soil suspension. The bacterial community tolerance to salt increased along the salt gradients with higher in situ soil salinity. In samples from the low-saline end of the gradient, bacterial growth rates in the soil suspension showed a clear concentration-response relationship to NaCl resulting in inhibition curves. This relationship gradually changed toward higher salt concentrations. In soil samples from high salinity sites, bacterial growth was no longer inhibited by adding high concentrations of NaCl to the bacterial soil suspension. In fact, adding NaCl even promoted bacterial growth rates. These results show that salinity played an ecologically significant role in shaping communities at the highly saline end of the gradients and provide evidence for a direct salt effect on the microbial community