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Ecophysiological traits underlying microbial succession after rewetting of soil from different precipitation regimes

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After the dry season in a Mediterranean climate grassland, the initial soil rewetting event causes a short period of high microbial activity, growth, and mortality. This wet up leads to microbial succession and community reassembly. Climate change in these semiarid environments is projected to cause reduced precipitation, which may affect the structure and function of the microbial community. However, we know little about how microbial functional traits underlie the rewetting succession, and how previous precipitation regimes affect these traits.

Using ^{18}O-water stable isotope probing (SIP), we conducted a replicated wet-up experiment in annual grassland soils that had been previously subjected to either average precipitation or 50% of the annual average. We traced microbial succession through 5 time points (0h, 24h, 48h, 72h and 168h) post wet-up. By combining SIP with metagenomics, we identified the actively growing organisms in both precipitation treatments and determined ecophysiological traits that were significantly more represented in growing organisms in each precipitation regime.

We observed a legacy effect of average vs. reduced precipitation by comparing the differential abundance of genes observed at time 0h in the two soil treatments. However, this legacy effect was surprisingly short-lived, implying that microbial community function rapidly “restarts itself” before the next growing season, regardless of the precipitation conditions experienced in the previous year. While growing organisms were significantly more abundant than non-growing organisms during the wet-up, the most abundant taxa were slow growers. In contrast, fast growing taxa were less abundant throughout the experiment, suggesting mortality plays a large role in the reformation of the microbial community.

We highlight temporal patterns and significant differences based on past precipitation in the abundance of carbohydrate utilization pathways, such as a higher representation of organisms capable of degrading cellulose in the reduced precipitation treatment. There were no temporal patterns in nitrogen cycling pathways; nitrogen acquisition appeared to be based mostly on ammonium assimilation and transport as well as proteases. In conclusion, altering preceding precipitation patterns had a large legacy effect on microbial community assembly and function

upon rewetting. However, the functional and compositional changes that resulted from altered precipitation had remarkably short-lived effects after the soils were rewetted.