Differential response of non-adapted ammonia-oxidising archaea and bacteria to drying-rewetting stress

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Global climate change is predicted to affect precipitation, leading to increased occurrence of drought followed by periods of heavy rainfall. Drying and rewetting affect biogeochemical cycles, submitting soil microorganisms to osmotic stress and altering diffusion, transport and concentration of nutrients. It has been shown that microorganisms in adapted soil ecosystems, such as Mediterranean soils that are experience very dry summer periods followed by heavy rainfall, resist and recover very quickly from drought. These include heterotrophic microorganisms, leading to a burst of mineralisation after rewetting, but also ammonia-oxidising archaea (AOA) and bacteria (AOB), which perform the first, rate-limiting step in nitrification, giving them a central role in the nitrogen cycle.

In contrast, little is known of the effect of drying-rewetting stress on 'non-adapted' microorganisms, inhabiting ecosystems that do not regularly experience drought/heavy rainfall cycles, or on the ecosystem functions in which they are involved. Furthermore, information on resistance and resilience of AOA and AOB to stresses, including drought, is lacking. We hypothesised that 1) non-adapted AO are poorly tolerant to drying-rewetting stress and 2) AOA and AOB have differential response to drought. More specifically, we hypothesised that the greater ammonium concentration in soil solution during drought and the inorganic N flush expected following rewetting would benefit AOB, due to their suspected greater tolerance to high ammonium concentration. To test these hypotheses, we sampled soil from mild Atlantic climate grassland (Lancaster, UK) and submitted it to drying-rewetting stress in a microcosm study. After two weeks of acclimation, half of the microcosms were subjected to three weeks of drought and then rewetted and left to recover for three weeks; the remaining microcosms were kept moist. Nitrification rate and AOA and AOB abundance (assessed by

real-time PCR targeting *amoA* genes) and community structure (assessed by DGGE targeting AOA *amoA* genes and AOB 16S rRNA genes) showed poor adaptation to drying-rewetting, illustrated by low resistance and resilience indices. AOA abundance and community structure were less resistant than those of AOB during drought, when ammonium concentration was higher in the soil solution, and less resilient than those of AOB after rewetting, when a dramatic flush of ammonium was measured. These results support our hypotheses and increase our understanding of AOA and AOB functional redundancy in the context of climate change.