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Microbial adaptations to temperature modulates carbon use efficiencies

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Decomposer microorganisms hold a key position in biogeochemical cycles and temperature is one of the dominant environmental factors that determine biological rates in ecosystems. The influence of temperature on microbial processes is therefore crucial for understanding soil carbon (C) dynamics. Also, our ability to understand the temperature relationship and adaptability of microbial processes in soil, is a prerequisite for improving modelling of the dynamics of the terrestrial ecosystem.

Here, we investigate how variation in long-term environmental temperatures influence the temperature relationships of microbial growth and respiration. We determine the temperature relationships of microbial communities of 56 different sites throughout Europe covering a wide climate gradient. We hypothesised (1) that a warmer climate would have selected for a microbial community with warm-adapted temperature relationships, and (2) that changes in the temperature relationship for growth would coincide with a similar relationship for respiration. To establish the temperature relationships of the microbial communities, we characterized the temperature dependence of bacterial growth, fungal growth and respiration. Dependencies were determined using brief (ca. 1-2 h at 25˚C) laboratory incubation experiments including temperatures from 0 to 35˚C.

The microbial temperature relationships indexed by the temperature minimum (T_{min}) correlated with the environmental temperatures such that warm sites were warm-adapted, and *vice versa*, as shown by T_{min} values ranging from ca. -20 ˚C to 0 ˚C. For every 1˚C rise in mean annual temperature (MAT), T_{min} increased by 0.22˚C and 0.28˚C for bacteria and fungi, respectively. Respiration was less dependent on MAT, increasing 0.16 ˚C per 1˚C. These relationships grew stronger when regressed against summer temperatures, and weaker when regressed against winter temperatures. Hence, microbial communities adjusted their temperature dependence for growth more than for respiration, and warm seasons had more impact than cooler seasons.

If it is possible to generalize these results, this would imply a situation where growth increases more than respiration when communities grow warm-adapted. This asymmetrical response of microbial adaptation has consequences for the carbon use efficiencies (CUE) of ecosystems. During warm periods, a warm-adapted community will operate with elevated CUE compared to a cold-adapted community, thus modulating the global carbon balance between soil and atmosphere.