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## Soil fauna drives vertical redistribution of soil organic carbon by long-term irrigation in a dry pine forest

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Summer droughts strongly affect soil organic carbon (SOC) cycling, but net effects on SOC storage are unclear as drought affects both C inputs and outputs from soils. Here, we explored the overlooked role of soil fauna on SOC storage in forests, hypothesizing that soil fauna is particularly drought-sensitive, thereby reducing litter incorporation into the mineral soil and, eventually, long-term SOC storage.

In a drought-prone pine forest (Switzerland), we performed a large-scale irrigation experiment for 17 years and assessed its impact on vertical SOC distribution and composition. We also examined litter decomposition of dominant tree species using litterbags of different mesh sizes and determined soil fauna abundance and community composition.

Long-term irrigation resulted in a C loss in the organic layers ( $-1.0 \text{ kg C m}^{-2}$ ) and a comparable C gain in the mineral soil ( $+0.8 \text{ kg C m}^{-2}$ ) in the first decade of irrigation, and thus did not affect total SOC stocks. Irrigation increased the mass loss of *Quercus pubescens* and *Viburnum lantana* leaf litter more strongly when meso- and macrofauna were included (+215%) compared to excluded (+44%). The enhanced faunal-mediated litter decomposition was paralleled by a many-fold increase in the abundance of meso- and macrofauna during irrigation. Moreover, irrigation led to a shift in Acari and Collembola community composition, with irrigation characterized by the presence of drought-sensitive species. In comparison, microbial SOC mineralization was less responsive to lower soil moisture. Our results suggest that the vertical redistribution of SOC with irrigation was mainly driven by litter incorporation through meso- and macrofauna, here accelerated by irrigation and suppressed by naturally occurring summer droughts.

Our study shows that soil fauna is highly sensitive to natural drought reducing the incorporation of C from organic layers to the mineral soil. In the longer term, this potentially affects SOC storage, decreasing the C stored in mineral soil. Therefore, soil fauna plays a key but so far largely overlooked role in shaping SOC responses to drought.

