Study shows bacteria in the soil can defy periods of drought

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ClimGrass, the field experiment in Styria, in which drought is simulated in combination with future climate conditions. Credit: Markus Herndl, HBLFA Raumberg-Gumpenstein

While many bacteria become inactive during dry spells, specific groups persist and even thrive. A new study, published in *Nature Communications* and conducted by the Center for Microbiology and Environmental Systems Science (CeMESS) at the University of Vienna,

offers ground-breaking insights into bacterial activity during drought periods, with implications for agriculture and our understanding of climate change impacts.

The images of the parched Po Valley in 2022 and this year's forest fires in Greece underscore the reality of extreme droughts—not just as news headlines but as immediate threats. The repercussions for humans and plant life are evident: crop failures, withered meadows, and water rationing. However, the impact of drought on soil microorganisms remains hidden from the naked eye.

Soil microorganisms play a pivotal role in ecosystems. They contribute to soil fertility, assist plants in nutrient absorption, and determine whether soils store or release CO_2, thereby influencing climate change trajectories. Until now, measuring the activity of microorganisms in dry soils and identifying which species remain active was challenging. Thanks to a novel method developed by scientists at the University of Vienna, bacterial activity during drought periods can now be observed.

In the study, soil samples from the "ClimGrass" climate change experiment in Styria were incubated with isotopically-marked water vapor. Growing bacteria incorporated the oxygen from the water vapor into their DNA, allowing for a measure of growth without adding liquid water to the soil.

"Most bacteria became inactive as dryness increased. However, this wasn't uniform across all microbial groups," explains Dennis Metze, Ph.D. student and lead author of the study. Moreover, bacterial growth during drought was influenced by whether the soils had been exposed to current or future climatic conditions, i.e., higher temperatures and CO_2 concentrations.

Microbial communities could become more drought

tolerant in future

In the heart of Styria, the "ClimGrass" experiment paints a vivid picture of the future. Here, 54 experimental plots simulate the world of tomorrow. Infrared heaters elevate temperatures to levels expected in future climate scenarios, while miniFACE systems adjust atmospheric CO_2 concentrations. Automated rainout shelters mimic severe summer drought events, creating a tangible representation of the challenges our ecosystems might face.

"Simulating future climate conditions actually resulted in more bacteria remaining active despite drought," explains Andreas Richter, professor of ecosystem research and head of CeMESS. "Under these simulated conditions, more drought-tolerant species were able to establish." A particularly drought-resistant bacterium from the Streptomyces genus became more prevalent in dry soils, accounting for a significant portion of total bacterial activity.

The filamentous growth of this bacterium might allow it to bridge disconnected pore spaces in drought-stricken soils, enabling it to access water and nutrients from distant sources. Previous studies have indicated that such bacteria might play a role in aiding plants to cope with drought.

The findings of this study offer invaluable insights into the resilience and adaptability of soil microorganisms in the face of increasing droughts due to climate change. As these tiny organisms play a monumental role in maintaining soil fertility, aiding plant growth, and regulating carbon sequestration, understanding their behavior is crucial for both our ecosystems and agricultural sectors.

As the world grapples with the challenges of climate change, food security, and ecosystem balance, research like this paves the way for informed strategies to safeguard our planet's health and the well-being of

its inhabitants.

More information: Dennis Metze et al, Microbial growth under drought is confined to distinct taxa and modified by potential future climate conditions, *Nature Communications* (2023). DOI: 10.1038/s41467-023-41524-y

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