iFAST: The International Forum on Advanced Environmental Sciences and Technology

A series of distinguished seminars by eminent scientists

8 a.m. CDT, 9 a.m. EDT, 1 p.m. GMT, 9 p.m. China
Wednesday, March 20, 2024

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https://www.bio.uni-jena.de/en/kuesellab

Kirsten Küsel is a professor of aquatic geomicrobiology at Friedrich Schiller University in Jena, Germany, and one of the founding directors of the German Centre for Integrative Biodiversity Research. Küsel brings a multidisciplinary approach to her work. Trained as a geoecologist, she operates at the intersection of microbiology, hydrology, geochemistry and soil science, with a primary focus on geomicrobiology. In her iFAST talk, she will offer an inspiring and cross-disciplinary examination of the subterranean biogeosphere. Her research emphasizes the significance of surface inputs in shaping modern groundwater and rock microbiomes, employing a diverse array of analytical techniques both in the field and laboratory, including in situ carbon fixation rate measurements and meta-omics applications. Her discoveries shed light on the ecological, metabolic and trophic strategies that influence the development, temporal dynamics and adaptations of groundwater microbes over time.

Shaping and feeding the subsurface microbiome

Abstract: The terrestrial subsurface contains almost all of Earth's freshwater reserves and hosts most of the planet's total prokaryotic biomass. The abundance and activity of microorganisms in the subsurface is constrained by factors such as rock lithology, permeability, available electron donors and acceptors, depth and hydrological isolation from the photosynthesis-fed surface. The limited number of access points complicates our knowledge of the subsurface microbiome. In this talk, I will present in-depth time series analyses that provide first insights into ecological strategies and factors influencing the establishment, temporal dynamics and adaptations of groundwater microbiomes to oligotrophic conditions, allowing us to better understand the metabolic repertoire and trophic interactions within one of the largest hidden habitats on Earth. Oligotrophic groundwaters often harbor microbes tuned to the lower end of the bioenergetic spectrum, like bacteria of the Candidate Phyla Radiation (CPR). CPR bacteria, which have small genomes characterized by predicted minimal biosynthetic and metabolic pathways, seem to be preferentially mobilized from soil surface ecosystems. Genome content comparisons of soil seepage and subsurface microbiomes suggest genome reduction caused by differences in selective forces. Radiocarbon (^{14}C) analyses of available C pools and microbial biomarkers show that carbonate rocks fuel subsurface microbes not only with fossil carbon but also with modern C, stabilized as fresh organic materials within rock fractures. Carbonate rocks also function as archives for genetic records of past microbial communities, pointing to a preferred utilization of sedimentary organic matter in the past. To understand another basis of subsurface life, we measured in situ carbon fixation rates in groundwaters using an ultralow ^{14}C labelling technique. Surprisingly, these rates fall within the range found for oligotrophic marine surface waters, indicating a substantial contribution of in situ primary production to subsurface ecosystem processes. We suggest that such sub-surface carbon fixation is fundamental to subsurface trophic webs, just as phototrophs are to marine biogeochemical cycling.

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