2026 IDEC Special seminar

Microbes versus Microplastics: Engineering Mangrove Microbiomes for Plastic Transformation

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Abstract

Plastic pollution has become a defining planetary-health challenge, with microplastics now detected across marine ecosystems, food webs, and human-associated environments. Mangrove soils are particularly important because they are major reservoirs of biodiversity and carbon, yet they also accumulate plastics delivered by coastal development and ocean circulation. Their complex microbiomes may therefore provide both an early-warning system for ecological disturbance and a source of biological solutions for plastic transformation.

In this seminar, I will present our work using Red Sea mangrove soils as a model to investigate how polyethylene terephthalate (PET) particles and seawater intrusion reshape microbial communities, and how these communities can be deliberately selected for plastic-transforming functions. We combined controlled soil microcosms, sequential enrichment cultures, physicochemical analyses of PET, and genome-resolved metagenomics. Seawater intrusion was the strongest driver of microbiome restructuring, while PET exposure produced more subtle community changes over the experimental period. By applying a top-down selection strategy, we obtained bacterial consortia capable of transforming PET. These consortia included Pseudoxanthomonas, Brevibacillus, and a newly described taxon, Mangrovimarina plasticivorans, and contained putative novel PET-active hydrolases. The genomic data further suggested that PET-derived compounds may be metabolized cooperatively, with different community members contributing complementary steps of the degradation pathway.

Together, these results show how ecological knowledge, microbial community engineering, and multi-omics can be integrated to discover new enzymes and consortia for plastic biotransformation. Such approaches are not a substitute for reducing plastic production and leakage, but they may complement recycling and bioremediation strategies within a circular bioeconomy. By enabling lower-energy biological processing and the recovery or upcycling of plastic-derived carbon, microbiome-based technologies could also contribute indirectly to carbon-neutrality goals while protecting the carbon-storage and ecosystem functions of mangrove habitats.

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