

Biology IS the Technology: The Microbial Ecology of Space Food Production and the Power of Aquaponics as a Learning Tool

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Abstract

To accomplish the objective of human missions to Mars and/or the long-term colonization of the moon, bioregenerative life support systems and food production systems will be absolutely necessary. Microbes are an essential and unavoidable component of these systems. In fact, these systems are driven by complex microbial communities about which we know very little, a glaring strategic knowledge gap in our ability to support extended human exploration in closed systems. Our laboratory has been working to use molecular ecological methods, including nanopore sequencing technology already deployed on the International Space Station, to understand the microbes in food production systems on Earth. Our ultimate goal is to inform the implementation of food production systems off-world. To date, we have sampled and sequenced the microbiomes of aquaponics systems, hydroponics systems, and fish ponds. Our results have revealed that the microbial communities in these systems are extremely diverse, and highly variable between systems. Along the way, we have discovered the power of aquaponics systems as teaching tools, and the capacity of students to perform high quality citizen science. By designing, constructing, and operating aquaponics systems, students better understand the role of microbes in the cycling of the elements in natural ecosystems, and in the human built environment. In partnership with schools and colleges, contributing new knowledge as citizen scientists, we are now exploring the relationships between the functioning of these systems and their microbial flora.