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ORGANIC GARDENS IN SPACE: ECOSYSTEM DESIGN FOR ENABLING DEEP SPACE EXPLORATION

Abstract

Human exploration of our Solar System and beyond is inherently dependent on the ability to provide sufficient life support to astronauts. This means providing air, food, water, and other elements needed to sustain life. In current spacecraft, this is done by storing and manipulating consumables. While this is feasible for low Earth orbit (LEO), longer duration missions to other planets or into deep space will require high quantities of these consumables and also limit resupply options due to distance and time constraints. This means that with current systems, higher volume and mass would be required, and therefore, higher cost. These limitations will prove to be formidable obstacles from engineering and financial points of view, and could limit our ability to make humans a truly space-faring species. However, humans utilize a life-support system every day provided by our biosphere, Earth's life zone. Within it, nearly infinite types of ecosystems varying in size and complexity exist, each with many of layers of connectivity and interdependencies. These ecosystems make up a closed system that not only supports life on the planet, but does so in a regenerative and self-repairing manner. Knowledge gained from studying the biosphere could prove useful for life support systems for future deep-space missions. This paper investigates the design of ecological space systems for the production and processing of components for life- support systems vital to human exploration. Established chemical and biological requirements for human life support in space and current ecosystem designs and research is used to create a space ecosystem roadmap leading to future scenarios for which space-based ecological resource systems are relevant. One such concept is defined and preliminary design work is presented for a proposed ecological resource system.