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RELEVANT ENVIRONMENT TESTING OF HYDROPONIC CULTIVATION SYSTEM IN CAVE ANALOG MISSION: INSIGHT FROM THE GEA PROJECT

Abstract

In a current context in which future long-duration space missions, which will soon see the return of man to the Moon and potentially the colonization of the lunar lava tubes, it is necessary to emphasize the need for systems that are life support for astronauts in extraterrestrial environments throughout the duration of the mission. Achieving self-sufficiency and independence from resources and supplies from the earth requires the development of systems that meet the requirements and constraints that are imposed by the potentially hostile environments explored, such as weight restrictions, absence of light, need for nutrients. Hydroponic systems for microgreens constitute a valid solution to these demands. It is in this background that the GEA project (Analog Explorations Group), led by Sapienza University of Rome - S5Lab research group and the Rome chapter of the CAI (Italian Alpine Club), was born. The project aims to carry out cave analog missions in order to simulate the environmental confinement conditions of lunar lava tube. The students and researchers of the project study, partly also from a behavioral point of view, the extended stay in these environments, carrying out scientific activities and developing experiments that interface with problems such as isolation, the absence of light, restricted spaces. The project satisfies the requirements to be met in future space missions, which were mentioned above, proposing the development of a microgreens cultivation system in caves. The following article, after a brief introduction to the project and its objectives, will describe in detail the development of the first version of the hydroponic system proposed during the 24-hour test, which took place in July 2023, in which all the systems necessary for the permanence inside the cave, communication and scientific experiments were tested, and their correct functioning was consolidated. The results obtained and the challenges faced during this first phase will also be illustrated. Subsequently, a second version of the cultivation system will be described which will

see the changes proposed following the first phase implemented; its operation during the 72-hours mission scheduled for July 2024 will also be illustrated. The iterative experimentation and refinement are tools through which the GEA project provides insights that can contribute to the development of innovative solutions for long-duration missions. Furthermore, the examination of hydroponic systems within the GEA framework offers potential solutions for lunar lava tubes exploration, aligning with scientific objectives for the future of space exploration.