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ASTROHAB-0 – A MODULAR RESEARCH PAYLOAD FOR LEO PURPOSES AS PRE-STAGE OF A LATER LUNAR LIFE SCIENCES RESEARCH AND LIFE SUPPORT UNIT

Abstract

For exploratory expeditions, far away from earth and thus from a possibility of material transport into the closed habitats, sustainable and stable life support systems will be essential to maintain an oxygenic atmosphere, remove carbon dioxide and produce biomass for food and feed. With new biotechnological methods organisms can be generated which not only perform these elementary tasks but simultaneously express bioactive compounds with e.g. antioxidant or antibacterial activities, thus adding extra value to the system. Such systems will be based on photosynthesis, a process by which plants and many microorganisms convert and store solar energy in chemical bonds. They remove CO2 from the atmosphere, fix it as carbohydrate (biomass) and simultaneously split water to yield atmospheric oxygen. Under specific conditions, certain photosynthetic microorganisms are able to evolve hydrogen gas, a promising alternative energy source. This process is catalyzed by the so called photosystem II (PSII) complex and represents the very beginning of biomass production.

Complex space radiation and other stressors like e.g. UV light can damage PSII and reduce photosynthetic efficiency and thus energy conversion. Thus, organisms foreseen to be used in life support systems during exploratory missions, needs to be investigated with respect to their adaptation potential and behavior under this complex mix of environmental conditions (microgravity, different types of radiation, temperature, vacuum etc.). For referring long-term exposure studies, the International Space Station with its internal and external facilities is a well suited starting point.

Testing of photosynthetic organisms under extreme environmental conditions here on Earth revealed a high adaptation capacity, let expecting promisingful results also for space. Studying these organisms at the molecular level yields valuable information about their survival strategies, which in turn can be exploited for space research/space biology in general. In addition, by mutagenic evolution during these experiments, new strains of better to certain space stress conditions adapted organisms can be yielded (in-vitro evolution).

In the present study it was evaluated how to combine such experimental approaches (for agar as well as liquid cultures) inside a preliminary hardware design which is well adapted to existing space infrastructures. In addition the evolution of such a system for later exploratory missions to outer space bodies is analyzed and a concept prepared for being later part of larger scaled Bioregenerative Life Support Systems including higher plants and animals was developed. Further specific issues of use during exploratory missions as automated analysis systems etc. were regarded also.