

Selected organisms for systems of life-support in closed bio-ecosystem, and the chemical circulation

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Living organisms on the earth have been evolved since its origin a long time ago. They equip several important functions affecting each other. Knowledge on those functions and interaction of the ecology is essential for secure design of a closed-ecosystem with limited number of living species under the harsh environments, such as space and deep sea or desert. The important elements related to the closed bio-ecosystem have to be discussed among the researchers, having each specialized field. Here, we will discuss the detail of species of several selected organisms for the closed bio-ecosystems and its chemical circulation.

Keywords: chemical circulation, closed bio-ecosystems

Dry heat tolerance of the dry colony in *Nostoc* sp. HK-01 for useful usage in closed bio-ecosystems

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Closed bio-ecosystem as an artificial design requires the high flexibility and versatility system. As one of elements for all of introduced organisms, heat tolerance is important one such closed environment. *Nostoc* sp. HK-01 is one of terrestrial cyanobacterium having a high dry tolerance and it has several ability, photosynthesis, nitrogen fixation and usefulness as a food, it is thought that it can be used for bio-chemical circulation in a closed ecosystem, including space. Besides, a study on each tolerance predicted at the time of introduction to a closed bio-ecosystem is necessary. Therefore, as one of the tolerance that are intended to space environment, dry heat (100 °C, 10 h) tolerance of dry colony in *Nostoc* sp. HK-01 has been investigated, but the detail function of them has not yet been elucidated. We focused on the extracellular polysaccharides (EPS) having the various tolerance, desiccation, low temperature, NaCl, and heavy particle beam. We will consider the function and useful usage of this cyanobacterium in closed bio-ecosystems after the consideration of the results of contribution of the possibility that EPS improves dry heat tolerance under a dry condition.

Keywords: bio-chemical circulation, closed bio-ecosystem, cyanobacteria, dry heat tolerance, extracellular polysaccharides, *Nostoc* sp. HK-01

Utilization of the terrestrial cyanobacteria

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The terrestrial, N₂ -fixing cyanobacterium, *Nostoc commune* has expected to utilize for agriculture, food and terraforming cause of its extracellular polysaccharide, desiccation tolerance and nitrogen fixation. Previously, the first author indicated that desiccation related genes were analyzed and the suggested that the genes were related to nitrogen fixation and metabolisms in *Nostoc(Anabaena)* sp. PCC 7120. In this report, we suggest possibility of agriculture, using the cyanobacterium. Further, we also found radioactive compounds accumulated *Nostoc commune* (cyanobacterium) in Fukushima, Japan after nuclear accident. Thus, it is investigated to remove radioactive compounds from soil by the cyanobacterium and showed to accumulate radioactive compounds using the cyanobacterium. We will discuss utilization of terrestrial cyanobacteria under closed environment.

Keywords: desiccation, terrestrial cyanobacteria, bioremediation, agriculture, decontamination

Evaluation of functional components in selected organisms as food after cooking in closed bio-ecosystem

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We have been studying life-support in closed bio-ecosystem to provide food and oxygen for the habitation area in the sever environment. To select the species of organisms is very important matter because it is difficult to use all the species of creature for the system. We have been proposing the several species of organism as the candidate species. In this time, we have selected and show terrestrial cyanobacteria and tree that have a possibility as high contributed materials for the induction into the closed systems. Here, we will discuss about the changes of the functional components produced from each materials, after their cooking.

Keywords: Cyanobacteria, tree plant, food, closed bio-ecosystem

Study of Closed Life Support System for Manned Space Exploration

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To further advance manned space exploration, a critical issue that must be addressed is recycling of resources, especially air revitalization and water reclamation. Japan is already a leader in terrestrial environmental technologies, and aims to apply this know-how to develop air and water recycling technologies for space applications. To support proposed post-ISS missions such as manned lunar or asteroid exploration and an Earth-Moon Lagrange point (EML1) space station, JAXA is developing an air revitalization system for an on-orbit demonstration on the International Space Station (ISS) early in the extended ISS operation period (2015-2020). The requirements for this technical demonstrator have been investigated and its specifications established. Regenerative life support functions include oxygen recovery from carbon dioxide using a combination of CO₂ reduction by a Sabatier process and O₂ generation by electrolysis. Each air and water re-vitalization subsystem is planned to be transported to the ISS separately by H-II Transfer Vehicle (HTV) launches in the Water Electrolysis. This paper presents the air re-vitalization system developed by JAXA, and gives details of water electrolysis in microgravity.

A technical issue with space electrolysis systems is that gas-liquid separation is fundamentally different in a microgravity environment to its behavior in a gravity field. It is supposed that the electrode surface will become covered with generated gas. In microgravity, the gas will have to be removed using forced convection. A water/gas separator will be used to separate gas and water.

Keywords: Life Support System, Manned Space Exploration, Air Re-vitalization, Microgravity, Closed System, Water Electrolysis

Human body and oxygen

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We found recently that a mild hyperbaric condition with a mild hyper oxygen-concentration ,which was maintained in the special container called as Ishihara's original oxygen capsule, was effective to treat infertility women patients. This result did let us realize again an importance of oxygen for cells and tissues of human body . In space development effects of microgravity, space radiation and other various environmental factors have been extensively

investigated and discussed, however we should also remember again that oxygen is the basic component to support our body in the space environment as well as on the earth. In this presentation I will summarize over again the meaning of presence of oxygen related to human body for future space development.

Keywords: oxygen, human body, space environment

Growth of *Hydrobryum puncticulatum*(*Yakushimakawagoromo*) may be blocked by the increase of *Melosira varians* in Isso River

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Hydrobryum puncticulatum (*Yakushimakawagoromo*), the national monument and endangered species are making their habitat only in Isso river of Yakushima. For the first time in our observation, the bloom of *Melosira varians* which is periphyton of diatom was observed to be covered over the *H.puncticulatum* from 2011. This impact for the *H.puncticulatum* is a serious concern. The purpose of this study is to clarify the cause of bloom of *M.varians*. We examined the annual variability of dissolved nutrient concentration which was most accessible to *M.varians*. As a result, there was no increase in concentration of NO₃-N, SiO₂-Si from 2009 to 2013. In addition, PO₄-P was much lower concentration(0.003±0.001 mg/ l). Therefore, we assumed that there was no relationship between the bloom of *M.varians* and dissolved nutrient concentration in Isso river. Meanwhile, the floating mud which was deposited in the bottom of the river has been continued during dry-spell. Tachibana et al (1986) reported that an algae can intake the suspended nutrient same as dissolved nutrient. It suggests that the *M.varians* and *H.puncticulatum* can take suspended nutrient.

Keywords: *Hydrobryum puncticulatum*, periphyton, Yakushima, nutrient

Environmental response in bacteria to an applied magnetic field

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Metabolic changes in living cells under various magnetic fields should be considered in closed-ecology on planets.

Magnetic fields may induce multiple effects in biological systems, including change in DNA replication or RNA transcription and modification of ion and protein flow across membranes. In recent years, influences of various electromagnetic fields on cell and organisms have been investigated by many researchers. However, the detailed mechanisms in the effects of magnetic field on organisms are still controversial.

In this study, we had focused on influences of the magnetic field on environmental microbes. Some bacteria susceptible to the applied magnetic field were isolated from the soil. To investigate expression changes of intracellular proteins involved in regulating cell growth by the applied magnetic field, cellular proteins in the bacteria cultured under the applied magnetic field were analyzed by SDS-polyacrylamide gel electrophoresis.

Keywords: Magnetic field, Bacteria, Growth curve

Useful utilization in closed bio-ecosystems of *Nostoc* sp. HK-01 having the tolerance of gamma-ray

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Photosynthetic organisms contribute to the circulation of oxygen or carbon dioxide and utilization of foods as a induced organism in closed bio-ecosystems. A terrestrial cyanobacterium, *Nostoc* sp HK-01, having a high drought tolerance, photosynthetic organism, is one of candidate organisms that can be introduced into the closed environment. It has a possibility that HK-01 has also a high gamma-ray tolerance in according to the results from several reports related to the interaction of drought tolerance and gamma-ray tolerance. Here, we will show the several influences on the growth of HK-01 after the exposure of gamma-ray in the dry colony.

Keywords: closed bio-system, cyanobacteria, gamma-ray tolerance, *Nostoc* sp. HK-01, photosynthetic organism