The possible interplanetary transfer of microbes: Assessing the viability of *Deinococcus* spp. under the ISS environmental conditions for performing exposure experiments of microbes in the Tanpopo mission.

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Introduction: The possibility of transfer of life between the Earth and exterrestrial has been proposed by Arrenius in 1908 [1]. The transfer prosess is called "panspermia". To investigate the panspermia hypothesis, numerous exposure experiments have been carried out on various some organisms e.g., spores of *Bacillus* spp. and the lichens, in space since 1960's [2]. The results suggested that some organisms might survive for a long period if the organisms are shielded from intense solar radiation [3, 4]. We have proposed to carry out the experiments on capture and space exposure of microbes at the Exposure Facility of Japanese Experimental Moduke of International Space Station (ISS) — Tanpopo mission [5]. Microbial candidates for the exposure experiments in space include *Deinococcus radiodurans*, *D. aerius* and *D. aetherius*. We have examined the survivability of *Deinococcus* spp. under the environmental conditions on ISS in orbit (i.e., long exposure to heavy-ion beams, temperature cycles, vacuum and UV irradiation).

Results and Discussion:

Among the space environmental factors, the solar UV is most lethal to microbes, and this UV correlated with this absorption wavelength of DNA. In this report, we examined the effect of solar UV radiation (172 nm, 254 nm respectively) on the deinococcal cell aggregates with different thicknesses to determine whether the size of the cell aggregate influences the cell survivability. Though the cells in thin layers of aggregates were killed by UV $_{172\ nm}$ radiation, large number of cells survived the radiation when the cell layer was thick (Fig. 1). The similar trend of survivability was observed for UV $_{254\ nm}$. Considering with these results, the submillimeter-sized aggregate cells that are sufficient to shield the cells in the inner layer from solar UV radiation after one-year exposure.

A One-year dose of heavy-ion beam irradiation (< 1 Gy) did not affect the viability of *Deinococcus* spp.

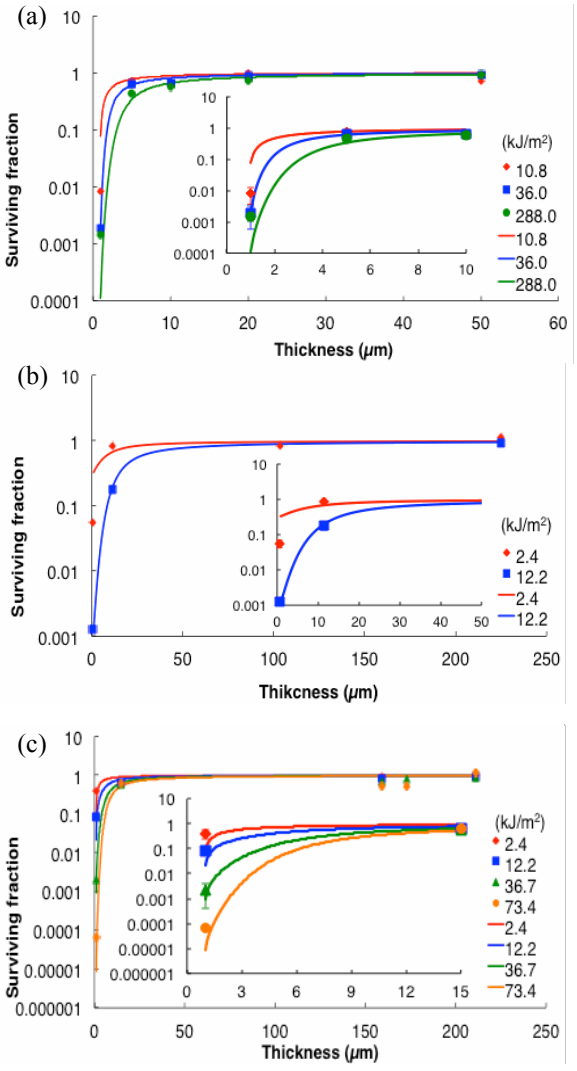

Fig. 1. Survival curves of *D. radiodurans* (a), *D. aerius* (b) and *D. aetherius* (c) following exposure to different doses of VUV$_{172}$ nm radiarion ubder vacuum.

within the detection limit. Vacuum (10^{-1} Pa) also had little effect on the cell viability. Experiments to test the effects of changes in temperature from 80 ^{o}C to –80 ^{o}C in 90 min (± 80 ^{o}C/90 min cycle) or from 60 ^{o}C to –60 ^{o}C in 90 min (± 60 ^{o}C/90 min cycle) on cell viability revealed that the survival rate decreased severely by the ± 80 ^{o}C/90 min temperature cycle.

The survivability of *Deinococcus* spp. after one-year in space was estimated by multiplying the survival rates after one-year exposure of heavy-ions, γ ray, temperature changes, vacuum and UV radiation. *D. aerius* cells will be killed when the temperature fluction is ± 80 ^{o}C/90 min cycle, but the would survive if the temperature fluctuation is less than ± 60 ^{o}C/90 min cycle. Based on our results, *Deinococcus* spp. could be suitable candidate microes for ecposure experiment in Tanpopo mission.

Conclusion:

From our results, we would like to emphasize the importance of microbial cell-aggregates as an ark for interplanetary transfer of microbes. We call this consept ‘massapanspermia’ [6]. The proposed experiment for the Tanpopo mission enhances the possibility that this massapanspermia concept might be true.

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