Survival and DNA Damage of Deinococcal Species in Space: Three Years of Microbe Space Exposure Experiment of Tanpopo Mission at Exposure Facility of Japanese Experiment Module of International Space Station

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Abstract

To investigate whether "panspermia" is possible, various space experiments have been performed (reviewed in Cottin et al., 2017, Space Sci. Rev. 209: 83–181). Previous exposure experiments of microbes in space revealed that microbes inside of shieldings (*e.g.* small fragments of rock, mixture with sugar or clay) with sufficient thickness to protect from UV irradiation survived in space for a long period (*e.g.* Onofuri et al., 2012, Astrobiology 12: 508–516) ("lithopanspermia" hypothesis). On the other hand, we proposed the possible interplanetary transfer of cell-aggregate in sub-millimeter to survive in harsh space environment (Kawaguchi et al., 2013, Orig. Life Evol. Biosph. 43: 411–428). "Tanpopo" mission has been performed using Exposure Facility (EF) of Japanese Experiment Module (JEM, KIBO) of International Space Station (ISS) (Yamagishi et al., 2007, Biol. Sci. Space 21: 67–75; Kawaguchi et al., 2016, Astrobiology 16: 363–376). "Tanpopo" means dandelion in Japanese.

To investigate survival of microbes and DNA damage induced in space, dried cells of radiotolerant eubacteria, three species of deinococci including *Deinococcus radiodurans* as well as DNA repair-deficient mutants of *D. radiodurans*, were put in wells of aluminum plates in Exposure Panels (EPs) and exposed in space at EF of JEM of ISS. We made three sets of samples for different space exposure periods. The space exposure of all samples for exposure experiment started at the end of May of 2015. Three EPs were exposed to space for one, two and three years, respectively: 384 days, 769 days, and 1126 days, to be exact.

Survival analysis of deinococcal species showed that the cell-aggregates with 100 μm-thickness hardly survived because of UV-irradiation, while the 500 μm-thick cell layer is sufficient to protect subsurface cells from UV-radiation in space (Kawaguchi et al., manuscript in preparation). In addition to the wild type strain of *D. radiodurans* (strain R1), the survival rates of DNA repair-deficient mutants of *D. radiodurans* were also investigated. *D. radiodurans*

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strain KH311, which is a deficient mutant of condensed nucleoid-dependent end joining pathway (CNDEJ), had the same survival rate in space as the wild type strain (strain R1). *D. radiodurans* strain UVS78 showed a survival rate equivalent to that of the strain R1 under dark conditions, whereas that of the strain UVS78 was less than the strain R1 under the exposure conditions. These results correspond to the fact that the strain UVS78 is deficient in two repair systems (nucleotide excision repair and UV damage excision repair) of DNA damage caused by UV light. The *D. radiodurans* strain rec30, which is deficient mutant of extended synthesis-dependent strand annealing (ESDSA) process followed by homologous recombination (HR), showed much less survival rate than the wild type strain (strain R1). The interpretation will be presented in the meeting.