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The microbe capture experiment in space: Fluorescence microscopic detection of microbes captured by aerogel

Tomohiro Sugino^{1*}, Shin-ichi Yokobori¹, Yinjie Yang¹, Yuko Kawaguchi¹, Sunao Hasegawa³, Hirofumi Hashimoto³, Eiichi Imai⁵, Kyoko Okudaira⁶, Hideyuki Kawai⁷, Makoto Tabata³, Yoshitaka Yoshimura⁸, Issay Narumi⁹, Norihiro Hayashi¹⁰, Katsumi Marumo⁴, Hajime Yano³, Masamichi Yamashita³, Kensei Kobayashi², Akihiko Yamagishi¹

¹Tokyo Univ. Pharm. Life Sci., ²Yokohama Natl. Univ., ³JAXA, ⁴Nagaoka Univ. Tech., ⁵Univ. Aizu, ⁶Chiba Univ., ⁷Tamagawa Univ., ⁸JAEA, ⁹Tokyo Inst. Tech., ¹⁰AIST

Microbes have been collected at the altitude up to about 70 km in the sampling experiment done by several groups^[1]. We have also collected high altitude microbes, by using an airplane and balloons^{[2][3][4][5]}. We collected new deinococcal strains (*Deinococcus aetherius* and *Deinococcus aerius*) and several strains of spore-forming bacilli from stratosphere^{[2][4][5]}. On the other hand, "Panspermia" hypothesis, where terrestrial life is originated from outside of Earth, has been proposed^{[6][7]}. Recent report suggesting existence of the possible microbe fossils in the meteorite of Mars origin opened the serious debate on the possibility of migration of life embedded in meteorites (and cosmic dusts)^{[8][9]}. If we were able to find terrestrial microbes in space, it would endorse the possibility that the terrestrial life can travel between astronomical bodies.

We proposed a mission "Tanpopo: Astrobiology Exposure and Micrometeoroid Capture Experiments" to evaluate possible interplanetary migration of microbes, organic compounds and meteoroids on Japan Experimental Module of the International Space Station (ISS)^[10]. Two of six sub themes in this mission are directly related to interplanetary migration of microbes. One is the direct capturing experiment of microbes (probably within the particles of clay) in space by the exposed ultra-low density aerogel. Another is the exposure experiment to examine survivability of the microbes in harsh space environment. They will tell us the possibility of interplanetary migration of microbes (life) from Earth to outside of Earth (or vice versa).

In this report, we will report whether aerogel that have been used for the collection of space debris and cosmic dusts can be used for microbe sampling in space. We will discuss how captured particles by aerogel can be detected with DNA-specific fluorescence dye, and how to distinguish microbes from other materials (i.e. aerogel and particles such as clay). The surface of microparticles captured by aerogel is often vitrified. The non-specific fluorescent light is often observed from vitrified materials. Therefore, we need to distinguish fluorescent light of stained microbes from that of spectral characteristics of vitrified materials and bleaching rate are going to be need to distinguish stained microbes with DNA-specific fluorescence dye and other materials such as clay and aerogel. We simulated the high-speed collision of micro-particles to the aerogel with the two stage light gas gun (ca. 4 km/s). The micro-particles containing dried cells of *Deinococcus radiodurans* mixed with clay material were used for the collision experiment, and the captured particles, which was stained after collision experiment, were observed with a fluorescence microscope. This experiment suggests that the captured microbes can be detected and be distinguished from clay materials.

Reference

[1] Yang, Y. et al. (2009) Biol. Sci. Space, 23, 151-163. [2] Yang, Y., et al. (2008) Biol. Sci. Space 22:18-25. [3] Yang, Y., et al. (2008) JAXA-RR-08-001: 34-42. [4] Yang, Y., et al. (2009) Internatl. J. Syst. Evol. Bacteriol., 59: 1862-1866. [5] Yang, Y. et al. (2010) Internatl. J. Syst. Evol. Bacteriol. (in press). [6] Arrhenius, S. (1908) Worlds in the Making-the Evolution of the Universe (translation to English by H. Borns) Harper and Brothers Publishers, New York. [7] Crick, F. (1981) Life Itself. Simon & Schuster, New York. [8] Chyba, C. and C. Sagan (1992) Nature 355: 125-132. [9] Sandford, S. A., et al. (2006) Science 314: 1720-1724. [10] Yamagishi, A., et al. (2008) International Symposium on Space Technology and Science (ISTS) Web Paper Archives. 2008-k-05.

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