

Upper Atmospheric Microorganisms Based Evaluation of Panspermia Hypothesis

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Terrestrial microbes may be transported via various ways into the upper atmosphere. Due to the environmental similarity of the upper atmosphere to outer space, knowledge of microbiology in the upper atmosphere would be valuable for assessing the chances and limits of microbial transfer from the earth to extraterrestrial bodies (i.e., Panspermia of terrestrial microbes).

We collected air dust samples in the upper troposphere and the stratosphere over Japan by using aircrafts or balloons. Microbial isolates from the samples were endospore-forming species (*Bacillus*, *Paenibacillus*, *Streptomyces*) and non-spore-forming *Deinococci* [1, 2]. Besides the evidence of microbial presence in the upper atmosphere, we show the possible presence of terrestrial microbes in space by height-dependent distribution of microbes [3].

The common characteristics of these upper atmospheric isolates were high resistance to radiation and desiccation, which likely enabled their survival in the environment of elevated radiation and desiccation. Specifically, the upper-atmospheric *Deinococcus* isolates exhibited extreme resistance to radiation (several times higher than bacterial endospores), the principle threat for microbial survival during interplanetary transfer. Therefore, Panspermia of viable *Deinococci* would be more likely than other terrestrial microbes [4]. Based on detailed characterization of the *Deinococcus* isolates, we proposed two new species *Deinococcus aerius* sp. nov. and *Deinococcus aetherius* sp. nov. [5, 6], which are now candidates for microbial exposure experiments in space.

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