The Post-Arrival Status Report to ISS and Upcoming Prospects of "Tanpopo", Japan's First Astrobiology Mission: Search for Terrestrial Microbes Potentially Reaching at 400 km Altitude

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Arrhenius proposed the interplanetary transfer of life in 1903 [1]. This hypothesis is called "panspermia". To test the panspermia hypothesis and investigate the upper boundary of the terrestrial biosphere, capture experiments of terrestrial microbes at high altitudes have been performed by balloons, aircraft and sounding rockets in the past, as reviewed by [2,3]. From these experiments, radiation-resistance microbes (e. g. *Bacillus* spores, *Deinococcus*) were isolated from samples collected at the troposphere and stratosphere. It is suggested that the terrestrial microbes may be transferred from ground to upper atmosphere by several mechanisms, e.g., powerful volcanic eruptions [4–6], asteroid/comet impact induced ejecta [7–9], wind storms [10,11], and electrostatic forces associated with thunder storms [12]. The bioaerosols are transported from ground to clouds by storms and winds [13]. We estimate that some bioaerosols that form cloud nuclei might be accelerated over the stratosphere by electrostatic forces associated with cloud-to-space discharges like blue jets and sprites.

In order to test the possibility of existence and transfer of terrestrial microbes at the thermosphere, we have developed the capture experiment apparatus for hypervelocity impacting microparticles such as meteoroids, orbital space debris and possibly terrestrial aerosols that may contain terrestrial microbes inside at 400 km altitude low earth orbit being onboard the International Space Station (ISS). First proposed in 2007 [14], our "Tanpopo" mission will become Japan's first astrobiology-driven space experiment to be launched and will start its first exposure period out of a total of four-year-long sample return mission in the spring of 2015.

Ultra low-density silica aerogels of 0.01 g/cc in aluminum Capture Panels (CP) will be placed at the Exposed Experiment Handrail Attachment Mechanism (ExHAM) pallet onboard the Kibo Exposed Facility of ISS. The CPs are to intact capture micrometeoroids, space debris and possibly terrestrial aerosols uplifted to the ISS orbit.

CPs will be prepared inside the Kibo module and exposed via the Kibo air lock hatch with its robot arm. If the Tanpopo successfully captures intact terrestrial microbes embedded in the aerosol particles within the aerogel CPs, it will push the upper limit of the existing altitude for terrestrial microbes from the stratosphere to ~400 km altitude.

After returning the first year's capture panel samples from the ISS via an earth return capsule around the mid-2016, we will search, detect, record, non-destructively and measure the captured particles and their impact tracks inside the returned aerogels by the original "keystone machine" with microscopes at ISAS/JAXA's dedicated "Tanpopo" clean room. Then impacted regions on the aerogel tiles not being contaminated will be dicected with the keystone machine.

After distributing the captured microparticles on the trailing face, which are dominated with impacts by particles orbiting around the Earth, i.e., space debris and terrestrial aerosols, if any. Then our plan is to stain these impact tracks and captured particles with SYBR Green I and detect the fluorescence of the SYBR Green I-stained microbial DNA [15]. We are now establishing methods to isolate microbial DNA from aerogels and to identify the species from which it was obtained by PCR assessment of small-subunit rRNA. We will compare the obtain DNA sequences with terrestrial DNA sequences using DNA database.

References:

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