

The Biopause Project: Balloon Experiments to Observe the Upper Boundary of the Biosphere

*Sohsuke Ohno¹, Norimune Miyake¹, Osamu Okudaira¹, Ko Ishibashi¹, Yuko Kawaguchi², Keisuke Maeda¹, Yuya Kakehashi³, Manabu Yamada¹, Kazuhiko Yamada³, Yusuke Takahashi⁴, Akihiko Yamagishi², Takahiro Segawa⁵, Satoshi Nonaka³, Hideyuki Fuke³, Gensuke Tokoro⁶, Kazuya Yamanouchi⁷, Tetsuya Yoshida³, Takafumi Matsui¹

1. Chiba Institute of Technology, 2. Tokyo University of Pharmacy and Life Sciences, 3. Japan Aerospace Exploration Agency, 4. Hokkaido University, 5. University of Yamanashi, 6. ISPA, 7. University of Tokyo

Determining the location of the “biopause” (i.e., the upper boundary of the biosphere of the Earth) and the biological flux across the biopause are key to our understanding of the universality, distribution, origin, and evolution of life in the universe. The most direct information available that can be used to investigate the biopause is the distribution and dynamicity of life in the middle atmosphere.

The Biopause project used scientific balloons of the Japan Aerospace Exploration Agency (JAXA) to develop an overview of the stratospheric biosphere and the dynamics of biological flux in the stratosphere. The descending inertial impactor sampler was transported to the stratosphere using a balloon, where the balloon was released from the sampler. Sample collection was conducted as the sampler descended by parachute. This method reduces biological contamination dramatically.

Our first balloon experiment was conducted on June 8, 2016. The valves of the sampler were opened during its descent from an altitude of 27 to 13 km as planned. The recovered sample was analyzed using a fluorescence microscope and a scanning electron microscope (SEM). Using a fluorescence microscope, we identified 21 microbes on the impactor plate in the sampler. We also analyzed the collected aerosol particles using an SEM.

We estimated the number density of stratospheric microbes including those that cannot be cultivated. This is the first observational study of stratospheric bioaerosols to include nonculturable species and to successfully constrain their number density. Nonculturable microbes are thought to constitute the majority of stratospheric bioaerosols. These results from the first balloon experiment of the Biopause project represent an important step towards the planning of future experiments that will improve our understanding of stratospheric life and assist with the identification and characterization of the biopause. In this presentation, we report the new results of the balloon experiment in this year and the initial results of the sample analysis.

Keywords: Biopause, Stratosphere, Extremophile, Astrobiology, Bioaerosol, Aerobiology