Preliminary insights into intracellular and division-related changes in surface properties of marine bacteria

*Yosuke Yamada[1]

1. JAMSTEC Japan Agency for Marine-Earth Science and Technology

In the ocean, the bacterial outer membrane represents the largest reactive surface possessed by organisms, where diverse particles and polymers are degraded by extracellular enzymes (Azam and Malfatti 2007). Nanoparticles (diameter: 1–1000 nm) are abundant in seawater and are composed of a wide variety of materials, including organelles and their fragments derived from phytoplankton, as well as other biologically released substances (Koike et al. 1990; Santschi 2018; Wells 2002). These nanoparticles, like low-molecular-weight organic substrates, microgels, and marine snow, are considered important nutrient sources for bacteria. The first step in nanoparticle utilization is their attachment to the bacterial cell surface. In general, surface properties such as stiffness, adhesiveness, and roughness are regarded as key parameters controlling particle attachment, influencing attachment efficiency and effective surface area. Culture-based experiments using isolated strains, such as *Escherichia coli*, have demonstrated that bacterial surface properties vary depending on bacterial species, environmental chemical conditions, and differences in outer membrane structures and the amount of surface-associated polymers. Previous studies (Yamada et al. 2023; 2025) revealed that surface properties of marine bacteria vary greatly among individual cells, and that roughness and stiffness in particular control nanoparticle attachment. These findings suggest that bacteria may alter their surface properties as survival strategies, such as for efficient organic matter utilization or avoidance of viral infection, and further indicate that such heterogeneity in surface properties may influence marine material cycling. However, our understanding of temporal variability and intracellular-scale dynamics of surface properties in marine bacteria remains limited. In this presentation, we introduce preliminary data obtained using atomic force microscopy to characterize variations in stiffness, adhesiveness, and roughness within single marine bacterial cells and during cell division. In the future, by increasing the number of observations, we aim to clarify the timescales and physiological and environmental conditions that regulate bacterial surface properties, thereby deepening our understanding of bacterial control mechanisms in marine material cycling.

Keywords: bacterial surface property, nanoparticle, material cycling

