【Grant-in-Aid for Scientific Research (S)】

Broad Section K

Title of Project： Aggregate-biosphere: Unveiling hidden regulatory processes in the oceanic carbon cycle

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Keyword：aggregates, genomic analysis, ocean carbon cycling, microbial community, biological carbon pump

【Purpose and Background of the Research】

The sedimentation of organic aggregates is one of the key mechanisms of "biological carbon pump (BCP)", i.e., the vertical carbon transport from the surface to the deep ocean. The BCP facilitates the storage of carbon in the deeper ocean on centennial to even millennial timescales and helps restrain the increase in the atmospheric concentration of carbon dioxide (Figure 1). Traditionally, organic aggregate dynamics have been studied using a physical model, where the role of microbes in the regulation of the BCP has been only superficially taken into account. This paucity of knowledge on complex interactions between microbes and organic aggregates seriously hampers the improvement of our ability to predict the response of oceanic carbon cycle to climate change.

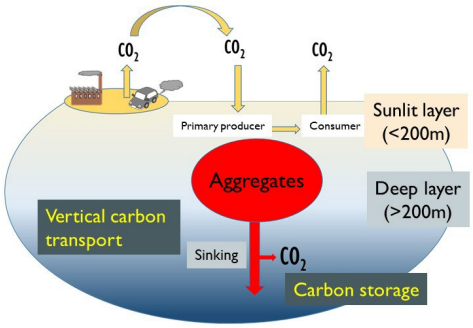

Figure 1. Biological carbon pump

In this research, we propose a new concept "Aggregate-Biosphere" to emphasize the role of diverse microbes, including bacteria, viruses, fungi and protists that flourish on organic aggregates, in exerting influence on their physical structure and dynamics (formation, growth and decay) (Fig. 2). Our goal is to clarify hidden regulatory mechanisms of BCP, involving so-far overlooked actions of the Aggregate-Biosphere. Our research team is composed of the experts from a multitude of scientific fields, including particle dynamics, biogeochemical cycling, microbial ecology, genomic analysis, bioinformatics and mathematical modelling.

【Research Methods】

We conduct field observations, manipulation experiments and mathematical modelling to answer the following three questions concerning the structure, function, and response of the Aggregate-Biosphere. (a) Are there general trends in the compositional pattern of the Aggregate-Biosphere? (b) What are the principal biotic interactions and metabolism that are involved in the regulation of aggregate dynamics? (c) What are the responses of the Aggregate-Biosphere and the BCP to changes in environmental conditions?

【Expected Research Achievements and Scientific Significance】

The expected outcome of this research includes a deeper understanding of the mechanisms by which oceans store carbon and the factors affecting this process. Through this, it contributes to the improvement of our ability to predict future changes in earth's climate and ocean ecosystems. Our research may also reveal a novel feature of the diversity in marine life and its functional consequences. This would contribute to broaden our perspectives concerning the functional role of biodiversity.

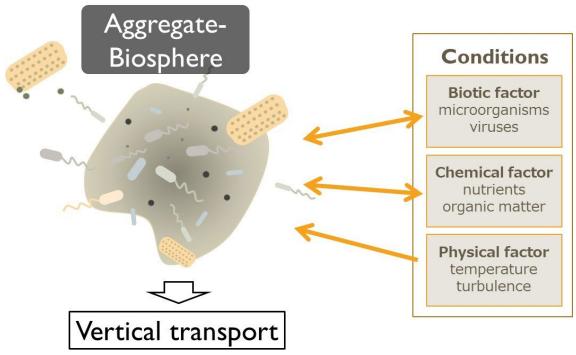

Figure 2. The concept of "Aggregate-Biosphere"

【Publications Relevant to the Project】

・Guidi et al. (2016) Plankton networks driving carbon export in the oligotrophic ocean. Nature, 532, 465-470.
・Yamada et al. (2018) Aggregate formation during the viral lysis of a marine diatom, Frontiers in Marine Science, doi.org/10.3389/fmars.2018.00167

【Term of Project】 FY2019-2023

【Budget Allocation】 154,300 Thousand Yen

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