Exploring the 'Dark Matter' of Microbiomes: Integrating Omics Strategies to Study Marine Symbiotic Microorganisms and Plastisphere

Ying-Ning Ho[1,2,3,4*], Che-Chun Chen[4,5], Chih-Hao Hsu[1], Yu-Ling Chen[1]

[1] Institute of Marine Biology, National Taiwan Ocean University, Keelung, Taiwan

[2] Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung, Taiwan

[3] Taiwan Ocean Genome Center, National Taiwan Ocean University, Keelung, Taiwan

[4] Doctoral Degree Program in Marine Biotechnology, College of Life Sciences, National Taiwan Ocean University, Keelung, Taiwan

[5] Doctoral Degree Program in Marine Biotechnology, Academia Sinica, Taipei, Taiwan

*E-mail: ynho@mail.ntou.edu.tw

Abstract

Marine microorganisms, including bacteria, viruses, microalgae, and fungi, play crucial roles in biogeochemical cycles, impacting climate change and ecological sustainability. They are essential in processes such as carbon sequestration, nitrogen fixation, and sulfur cycling. Additionally, they support food webs, degrade pollutants, and are harnessed in biotechnology for sustainable solutions, all of which are vital for maintaining Earth's environmental balance. Moreover, the symbiotic microorganisms of marine organisms play an important role in enhancing their hosts' resilience to environmental adversity. We used integrated omics strategies to study the symbiotic microorganisms of marine organisms. Additionally, we used metabarcoding and metabolomics to investigate the attraction of surrounding organisms to the microbial ecosystem formed by marine plastic debris, known as the plastisphere. Consequently, the exploration of marine microbial resources is of paramount importance for environmental sustainability. We also developed the Microbial Community-Guided Culture Strategies (MCGCS) system, which uses a portable and rapid Oxford Nanopore Technologies sequencing device to predict specific microbial culture media and conditions. This system, through rapid targeted metagenomic sequencing approaches and real-time analysis, enables the testing of multiple carbon sources of interest and facilitates the discovery of target microbes in samples for cultivation. As our ability to culture and comprehend these microorganisms grows, so does our capacity to contribute to the sustainability and conservation of the marine environment.