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Unraveling virus-phytoplankton interactions using integrated cultivation and multi-omics approaches

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Phytoplankton serve as the foundational producers in marine ecosystems, with marine viruses critically influencing their populations through infection. This study employs both cultivation and cultivation-independent approaches to investigate the dynamics and mechanisms of virus-phytoplankton interactions. We used metagenomic Hi-C, a culture-independent method, to identify virus-host pairs and track their seasonal dynamics in natural phytoplankton communities. This approach improved the quality of metagenome-assembled genomes and revealed extensive virus-host linkage events. We also developed a dsDNA virus enrichment and shotgun sequencing method, successfully assembling 80 genomes of prasinoviruses, known to infect the green algae Mamiellales. Our research provided the first direct estimation of 94% accuracy in correlating genome similarity to host range. Analyses of the assembled genomes revealed unexpected host-switching across diverse algal lineages, challenging the existing paradigms of host-virus co-speciation and highlighting the dynamic nature of viral evolution. We also detected instances of horizontal gene transfer between prasinoviruses and their hosts, including a novel alternative oxidase. Additionally, diversifying selection on major capsid proteins suggests a continuous coevolutionary arms race. To further our research, we isolated prasinoviruses and their Mamiellales hosts from the waters of Hong Kong, establishing culturable model systems that are instrumental for investigating co-evolutionary processes.

About the Speaker

Charmaine Yung is an Assistant Professor in the Department of Ocean Science at the Hong Kong University of Science and Technology (HKUST), where she has been based since 2019. She began her academic journey at HKUST, earning a Bachelor of Science in Biology in 2009. Charmaine then pursued a Master of Philosophy in Environmental Microbiology under the supervision of Prof. Stephen Pointing at the University of Hong Kong in 2011, further honing her expertise in the field. Following her master's, Charmaine embarked on a PhD in Marine Science and Conservation at Duke University, which she completed in 2016. Her doctoral research focused on thermal adaptation of marine bacteria. After her PhD, Charmaine undertook a postdoctoral position at the Monterey Bay Aquarium Research Institute from 2016 to 2018, where she specialized in green algal research. She then continued her postdoctoral work at the GEOMAR Helmholtz Centre for Ocean Research Kiel from 2018 to 2019.