Everything else

Thu. Nov 12, 2026 11:00 AM - 12:30 PM JST | Thu. Nov 12, 2026 2:00 AM - 3:30 AM UTC | Posters (3F)

Posters 1

[KSxAOV1I-17] Integrating Plankton Traits and Trophic Interactions into a Marine Ecosystem Digital Twin

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Marine Ecosystem Digital Twins require more than spatially explicit observations of ecosystem states; they also need representations of the biological processes that regulate ecosystem dynamics. Our previous experimental studies have investigated diverse interactions among bloom-forming dinoflagellates and their potential predators, providing quantitative information on feeding, ingestion, growth, survival, mortality, swimming behavior, and physiological traits.

These studies demonstrate that plankton interactions cannot be represented simply by prey abundance and predator abundance. Predator–prey interactions are strongly species-specific and can be mediated by prey traits and environmental conditions. For example, different heterotrophic protists showed contrasting feeding and growth responses to the kleptoplastidic dinoflagellate Shimiella gracilenta, while swimming and behavioral characteristics influenced predator–prey interactions. Studies of Alexandrium species revealed substantial interspecific variation in bioluminescence and its relationship with physiological and phylogenetic characteristics. Salinity experiments further demonstrated that environmental conditions can modify growth, cell characteristics, and bioluminescence of Noctiluca scintillans, Polykrikos kofoidii, and Alexandrium mediterraneum. More recently, experiments with Karenia bicuneiformis and Karenia selliformis demonstrated contrasting effects on heterotrophic protists and the copepod Acartia hongi, ranging from successful feeding and survival to strong mortality responses.

Based on these findings, we propose a trait-based plankton interaction module for integration into a Marine Ecosystem Digital Twin. The module links environmental conditions and species traits to physiological state, grazing interactions, population growth, and mortality, providing a mechanistic bridge between monitoring observations and ecosystem processes. This framework represents a step toward transforming experimentally derived ecological knowledge into dynamic, predictive components of a Marine Ecosystem Digital Twin. This research was supported by Korea Institute of Marine Science & Technology (KIMST) Promotion funded by the Ministry of Oceans and Fisheries, Korea(RS-2026-25538840, Incheon-Gyeonggi-Chungcheong Sea Grant).

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