THE UNIVERSITY OF HONG KONG
SCHOOL OF BIOLOGICAL SCIENCES

Postgraduate Student Public Seminar

"Ecosystem functions of sea cucumbers in coastal habitats of a megalopolis"

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on Thursday 25 May, 2023 at 10:00 am
Room 6N-11, Kadoorie Biological Sciences Building

Abstract

Holothurians (sea cucumbers) play a key role in the biogeochemical processes of many soft-bottomed ecosystems, as they remove organic matter in benthic sediment through deposit-feeding and release inorganic nitrogen to the water column as a metabolic by-product. These ecological benefits of holothurians maintain key ecosystem functions in coastal habitats under constant anthropogenic impacts. Meanwhile, ocean warming could expose sea cucumbers to temperatures beyond their optimal thermal range, leading to a direct alteration of their physiological performance that could consequentially transform ecological functions. In this thesis, I examined the effects of anthropogenic eutrophication and ocean warming on *Holothuria leucospilota* in coastal habitats of a megalopolis. I also established an automatic holothurian detection model with deep learning to support efficient quantification of sea cucumber populations and the evaluation of their ecological roles on a regional scale.

Field experiments revealed that the efficiency of sea cucumbers on removing organic load could be positively related to the seasonal bioavailability of sedimentary organic matter in enriched systems, which illustrated that the eutrophic characteristics could moderate the effects of holothurians in ameliorating eutrophication in enriched habitats. Predicted future ocean temperatures will also alter the ecological functions of tropical sea cucumbers, where higher predicted temperatures caused mass mortality which possibly incapacitate their ecological functions in tropical habitats. To further understand the ecological values of sea cucumbers on a system level, I developed an automatic holothurian detection model that supports holothurian density computations over large spatial scale using convulsion neuron networks with optimized data augmentation for model training. The output model has a mAP of 0.93, which is the best among holothurian detection models of similar kind. Making use of this model, I then extensively surveyed *H. leucospilota* populations to estimate their total contribution on nutrient mineralization in coastal habitats of Hong Kong, which exemplifies the practicality of utilizing machine learning models to facilitate the evaluation of ecological functions at a system level.

Overall, holothurians aid the mineralization of nitrogen nutrients but ocean warming could debilitate their ecological functions. This thesis also demonstrated the potential of projecting ecological contributions from an organismal level to broader scales using deep learning. These combined approaches have enhanced the current understanding of the ecological roles of holothurians and highlighted the advantages of incorporating machine learning in ecological studies.

--- ALL ARE WELCOME ---