Investigating the interplay between microplastic pollution and ocean warming

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The ocean, covering over 70% of the Earth's surface and intertwined with the lives of billions, faces unprecedented stress from human- induced pressures breaching critical planetary boundaries (Kummu *et al.*, 2016). Climate change, overfishing, pollution, and habitat destruction collectively jeopardize marine ecosystems and the services they provide to coastal communities (Abram *et al.*, 2022; Cooley S *et al.*, 2022). Among these stressors, plastic pollution emerges as a pervasive threat, with plastics permeating marine environments from the sea surface to the deep sea (UNEP, 2021).

My thesis investigates the combined impacts of microplastic (MP) exposure and ocean warming (OW) on *Nitokra spinipes*, a crucial benthic copepod, unraveling their effects on metabolism, growth, development, and population dynamics. The investigation spans realistic and high MP concentrations (10^2 and 10^4 particles mL^{-1}) alongside varying temperatures (22°C vs. 25°C). The study probes into the vulnerability of different life stages of *N. spinipes*, addressing mortality rates and developmental impacts.

Intermediate Results
Based on the preliminary findings, there is a noticeable difference in the average feeding rates of copepods at two different temperatures. For the initial treatment (10^2 PTCs mL^{-1}), the average feeding rate stood at 281.3 cells $copepod^{-1}$ h^{-1} at 22°C and 902.7 cells $copepod^{-1}$ h^{-1} at 25°C. In the second treatment (10^4 PTCs mL^{-1}), the average feeding rate was 512.7 cells $copepod^{-1}$ h^{-1} at 22°C and 961.7 cells $copepod^{-1}$ h^{-1} at 25°C. Notably, at 25°C, the feeding rates appear to have shifted towards higher values in comparison to the 22°C experiment ($p = 0.0551$).

Employing a Dynamic Energy Budget-Individual Based Model (DEB-IBM), this study integrates empirical filtration rate data to simulate copepod population dynamics over a year, illuminating the theoretical effects of OW and MPs on *N. spinipes*. The ecological relevance of these findings for marine ecosystems, particularly the Belgian North Sea coast, is elucidated. Implications on carrying capacity, intrinsic growth rates, and ecosystem functioning are assessed.

Nitokra spinipes serves as the focal model species due to its ecological significance in nutrient cycling, acting as a crucial link between primary producers and higher trophic levels. These benthic copepods, susceptible to MP ingestion, play a pivotal role in the vertical transport of organic matter, influencing carbon storage and nutrient distribution in aquatic ecosystems (Giering *et al.*, 2014; Turner, 2015).

This investigation strives to fill existing knowledge gaps concerning the impacts of MPs on benthic fauna, aiming to unveil the broader implications for marine ecosystems. By unraveling the intricate interplay between MPs and OW on *Nitokra spinipes*, this research contributes to understanding multi-stressor scenarios in aquatic environments, helping to understand the real-world impact of MPs on marine organisms. Stressors, encompassing ocean warming, acidification, deoxygenation, and marine heat waves, often interact in complex ways, influencing biological systems differently compared to single stressors (Catarino *et al.*, 2022; Griffen *et al.*, 2016).

Keywords
Plastic Pollution; Microplastics; Ocean Warming; Multiple Stressors; *Nitokra Spinipes*; Feeding Rates; Population Dynamics; Ecological Impact; Benthic Copepod