Impact of global warming and plastic leachates from conventional and bio-based polymers on the growth of *Phaeodactylum tricornutum*

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Global warming and plastic pollution are two human-induced environmental stressors of rising concern owing to their potential impact on the ocean health. To tackle plastic pollution, sustainable alternatives to conventional fossil fuel-based plastics are being developed, like polylactic acid (PLA), a bio-based polymer made from natural-sourced feedstocks. In the marine environment, plastic additives and low molecular weight oligomers can be released and leached from the plastic to the surrounding seawater. Ultraviolet (UV) irradiation, which is one of the most important triggers of polymer degradation, may enhance the chemical leaching process and potentially alter the characteristics of the leachates (i.e. mixture of leached compounds). However, knowledge gaps exist concerning the effects of UV-weathered leachates especially from bio-based polymers to marine life. Hence, their potential effects combined with global warming is even less well understood.

In this master thesis, we have three research questions. The first aim is to assess the effect of plastic leachates from a bio-based polymer, in comparison to a reference conventional fossil fuel-based polymer on the growth of a marine diatom. The second aim is to investigate whether the possible effect of plastic leachates is enhanced or diminished by UV irradiation. The third aim is to understand the combined effects of leached compounds and increased water temperature on the growth of a marine diatom. To do so, we exposed the marine diatom *Phaeodactylum tricornutum* to a dilution series of plastic leachates from pristine and weathered self-reinforced PLA (SR-PLA) and self-reinforced polypropylene (SR-PP) following the ISO 10253:2016 protocol. The UV-weathered plastic was obtained by exposing SR-PLA and SR-PP strips (0.13 x 2 x 7.5 cm) to UV radiation for 57 days simulating 18 months of natural solar exposure. To obtain the leachates, we incubated the plastic strips in artificial seawater for 20 days in the dark. Following the leachate tests, we determined the EC50 (I.e. half-maximal effective concentration) to algal growth of four known oligomers and additives of PLA and PP, i.e., di-lactide, dodecan-1-ol, 2,4-di-tert-butylphenol, and tributyl O-acetylcritrate.

Our preliminary results on SR-PLA leachates showed that neither pristine leachate nor UV-weathered leachate influenced the growth of *P. tricornutum*, and up to 57 days UV radiation had no effect on the toxicity of SR-PLA leachates. The determined EC50 of di-lactide, dodecan-1-ol and 2,4-di-tert-butylphenol are 341 ± 30 mg/L, 1.86 ± 0.06 mg/L and 1.50 ± 0.01 mg/L, respectively. No growth inhibition was observed due to tributyl O-acetylcritrate up to 98 mg/L. Forthcoming experiments will be performed with these four compounds at increased seawater temperature (i.e., 25 °C) following a full factorial experimental design. We expect that our results contribute to assess the link between multiple stressors for phytoplankton growth and to assess the potential ecological impacts of new bio-based polymers.

Keywords: Ecotoxicity; Plastic pollution; Global warming; Phytoplankton