



Abstract

The abundance of plastics in bodies of water has exponentially increased, which has catalyzed researchers to explore the consequences that arise from this trend. Although there have been discoveries published, none of them have reported the potential effect of plastics on polychlorinated biphenyls (PCBs) accumulation in zooplankton—a primary food source of many higher trophic organisms in the aquatic ecosystem. The primary goal of this study is to determine if the adsorption of PCB-126 on microplastic enhanced the accumulation of this compound in *Daphnia magna* and biological performance (i.e., growth, reproduction) of the organisms. *Daphnia magna* was exposed to PCBs in water with the presence of microplastic or no plastic for 21 days. Results showed that *D. magna* consumed significant number of microplastics. PCB-126 was adsorbed on microplastics and carried into the organism's gut and resulted in higher accumulation of PCB-126 in the body of *D. magna*. While concentration of PCB-126 was not detected in control *D. magna*, exposed *D. magna* with the presence of microplastics had a body PCB-126 concentration of 30.28 mg/kg wet weight, which was significantly higher than the body PCB-126 concentration of exposed *D. magna* with no microplastics (17.39 mg/kg wet weight). Results of biological measurements showed that although there was no significant difference in the performance of exposed organisms versus the control organisms, *D. magna* appeared to perform poorer in water with the presence of microplastics and PCBs than in the control. Results of the present study poses a potential risk of plastic and PCBs transfer over to higher trophic organisms in the food chain.

Introduction

- Since the 1950s when the mass production of plastics began, the demand of plastics increased exponentially. As a result, marine and freshwater ecosystems are contaminated with plastics. Great Lakes is one of the freshwater systems that has high plastic concentration, up to 46,000 particles/km³ (Reference?).
- The rising concentrations of microplastics emphasize the urgency to address the effects of plastics in the natural ecosystem. Research has shown plastic consumption by aquatic organisms and potential transfer and carry organic pollutants through the food chain in aquatic ecosystems.
- Polychlorinated Biphenyls (PCBs) are a group of man-made organic chemicals that were domestically manufactured from 1929 until it was banned in 1979 due to its toxicity and long life in the environment.
- This study explores the effects of microplastics ingestion and enhancement on PCB accumulation in freshwater invertebrate, *Daphnia magna*.

Objective

The objective of this study was to determine the potential enhancement of microplastics on 3,3',4,4',5-Pentachlorobiphenyl (PCB-126) accumulation in *D. magna* and effects on survival, growth, and reproduction of *D. magna* due to consumption of microplastics with the presence and no presence of PCB-126.

Materials and Methods

- **Organism:** 7 day old *D. magna*, cultured in moderately hard water (MHW), EPA method.
- **Microplastics:** 63-75µm green fluorescent microspheres. (Cospheric Inc.)
- **Contaminant:** PCB-126
- **Solvent:** Dimethyl sulfoxide (DMSO)
- **Experimental design:** 21 d experiment of 3 controls and 2 treatments with 4 replicates each
- Negative control: MHW
- First Positive Control: MHW and 400 mL DMSO
- Second Positive Control: MHW, 400 mL DMSO, and 20 mg /L size 63-75µm green fluorescent microspheres.
- Two treatments:
 - T1: 20 mg/L microspheres and 1 µg/L PCB
 - T2: No plastics and 1 µg/L PCB, containing 10 *D. magna* per replicate.

- **Testing conditions:** Standard laboratory conditions: temperature of 23 ± 2 °C, light photoperiod of 16h light and 8h dark,, feeding regime of 0.1 ml of both algae (*Selenastrum capricornutum*) and YTC (yeast-trout chow-cerophyl) per organism per day, water renewal every two days with of new microspheres measured precisely to the milligram.



Experimental design and test layout

- **Extraction of Daphnia for PCB analysis:** After removal from the water, *D. magna* were sonicated in 5 mL of methylene chloride for 20 minutes to extract PCB. The methylenechloride was removed in rotoevaporator. The *D. magna* were vortexed, sonicated briefly in 300 µL of hexane, and pelleted in table top centrifuge. The hexane was transferred to an autosampler vial for analysis of PCB-126 by GC-ECD.

- The injector temperature: 250° C
- The retention time of the PCB 126: 36.2 minutes
- Carrier gas: helium at flow rate of 1.5 mL min⁻¹
- Sweep gas: methane at 30 mL min⁻¹

Results

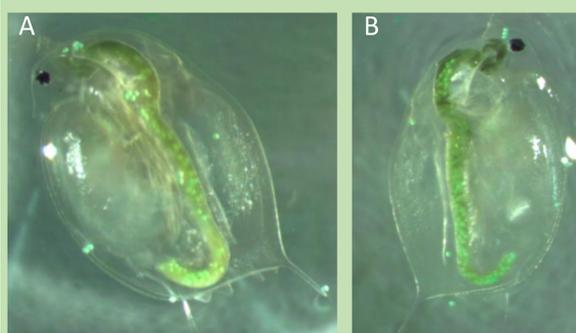
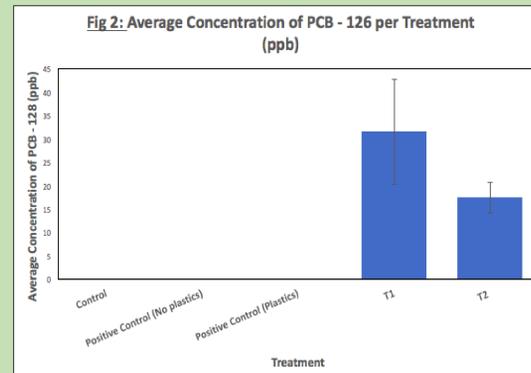
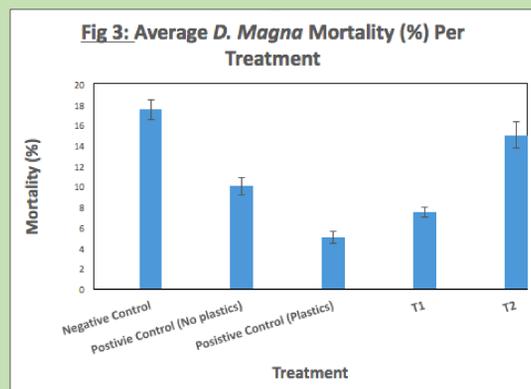


Fig. 1: *D. magna* gut filled with ingested particles of 63-75µm polyethylene microspheres (A: positive control with plastics, B: PCB and plastic exposure)

- *D. magna* accumulated more PCB-126 when microplastics were added in the exposure media (T1, Fig. 2) than no addition of microplastics (T2, Fig. 2). This indicates an enhancement of microplastics on PCB-126 accumulation in *D. magna*.



- Mortality of *D. magna* were not significantly different between controls and PCB and plastic exposure treatments (Fig. 3).



- Although the number of neonates produced per adult per day appeared to be lower in PCB and plastic exposure treatments, there was no significant difference in the reproductive and body measurements between controls and exposure treatments (Fig. 4, Fig. 5, Fig. 6).

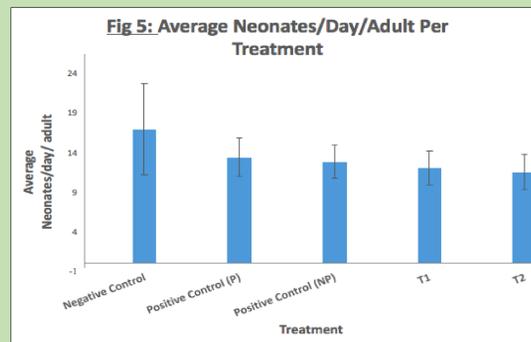
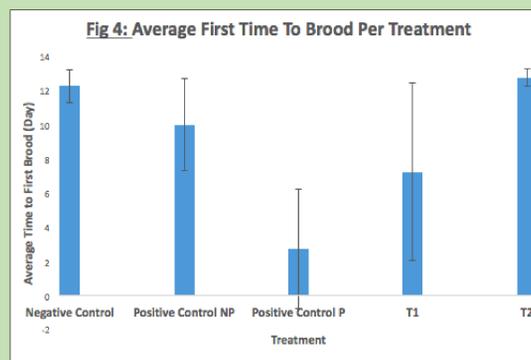
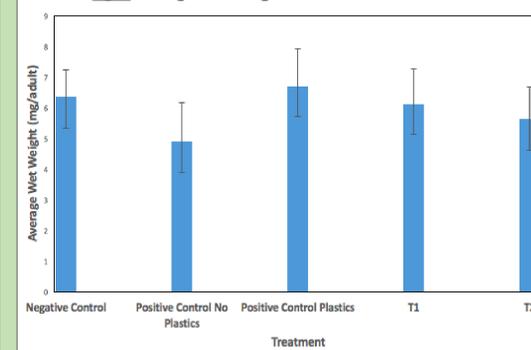


Fig 6: Average Wet Weight Per Adults Per Treatment



Discussion

- While concentration of PCB-126 was not detected in control *D. magna*, exposed *D. magna* with the present of microplastics had a body PCB-126 concentration of 30.28 mg/kg wet weight, which was significantly higher than the body PCB-126 concentration of exposed *D. magna* with no microplastics (17.39 mg/kg wet weight).
- Results of biological measurements showed that although there was no significant difference in the performance of exposed organisms versus the control organisms, *D. magna* appeared to perform poorer in water with microplastics and PCBs than in control waters
- It is likely that the concentration of the PCB-126 was too low to cause significantly negative effects on *D. magna*.
- Elevated PCB-126 concentration in *D. magna* when microplastics were present in the exposure media indicates an enhancement of PCB-126 accumulation by plastic consumption by *D. magna*. This poses potential risks of increasing PCB-126 accumulation through the food chain.

Conclusions and suggestion

- Results of the present study indicated plastic consumption by *D. magna* and enhancement of microplastics on PCB accumulation in *D. magna*.
- Plastic and PCB exposures at concentrations used in the present study did not significantly affect biological performance of *D. magna*.
- More research should be conducted to characterize the potential PCB transfer of microplastics through the food chain.

Acknowledgement

We would like to thank Sean Barrett for assisting with conducting the experiments.