Ghost Shrimp and Polystyrene, Investigating the Ingestion and Breakdown of Microplastics

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Abstract

- Our goal is to investigate microplastics in the ocean and the bioaccumulation in marine life because there are unknown consequences of plastic degradation
- What we have accomplished:
  - Developed an experiment to collect data, measuring polystyrene's impact on water chemistry
    - Found little change in water chemistry over a 30 day period
    - Discovered microplastic particulate matter from the degradation of polystyrene
  - Conducted extensive research on bioaccumulation in marine life
    - Developed an experiment to investigate the bioaccumulation of plastics in ghost shrimp

Introduction

- In 1907 synthetic plastic was created
- Plastics can end up in the ocean from being carried by rivers into lakes and oceans (NOAA, 2018)
- Natural processes can degrade plastic (such as abrasion for ocean waves) creating microplastics less than 5mm in size (Barr)
- Microplastics in the ocean can be ingested by marine and wildlife and be biomagnified (Guern, 2018).
- When plastic breaks down, it becomes microplastic
- Pieces of microplastics may enter the system of marine life, but the rate of accumulation is unknown.
- Polystyrene will be artificially degreated to examine any change in ocean water chemistry
- Ghost shrimp will be used to determine the rate of bioaccumulation of polystyrene microplastics, in marine life (not completed because of COVID-19)

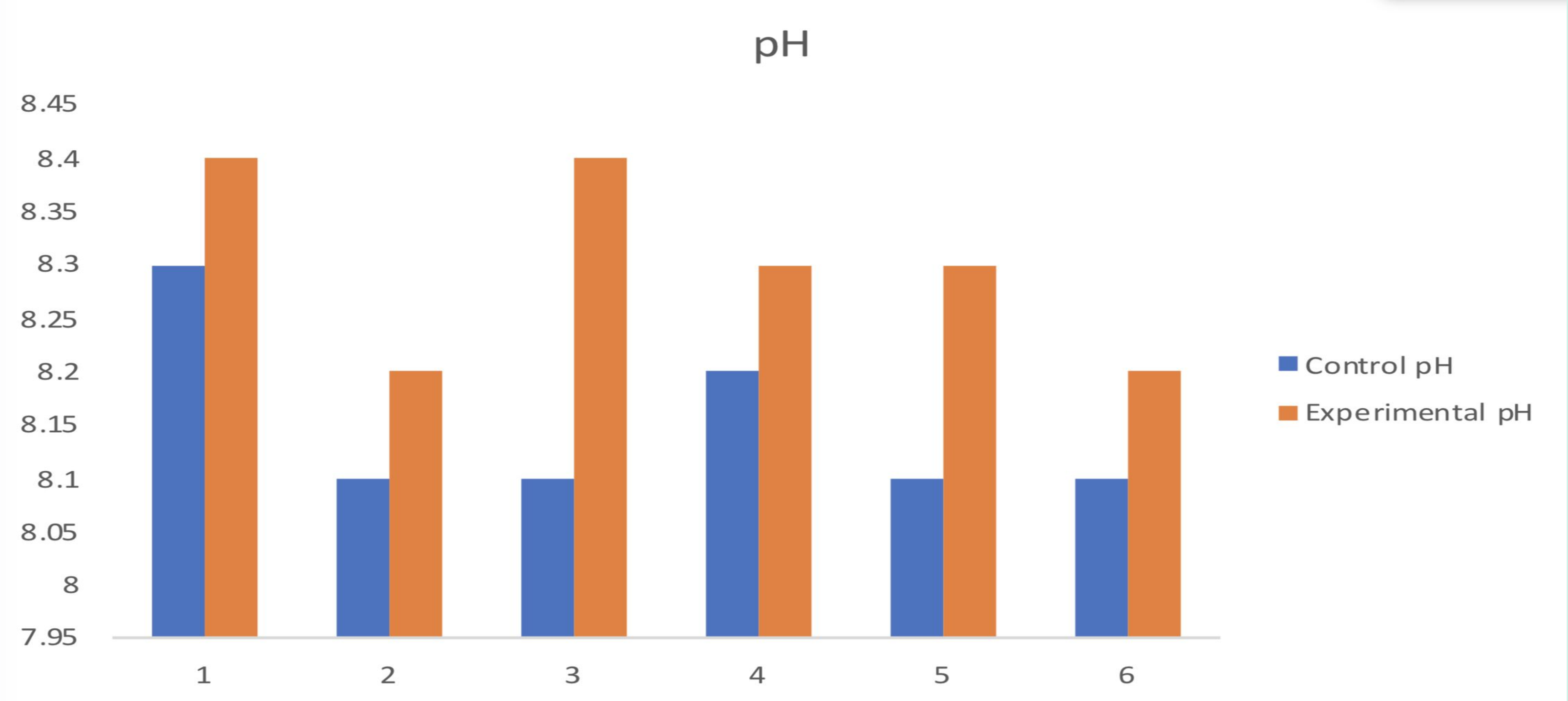
Methods

- Two ten gallon tanks filled with Artificial Sea Water (ASW) at a salinity of 35ppm using a refractometer and kept at 23°C with pumps to cause movement in the water
- Tank one (control): without plastic
- Tank two: 9.61 grams of approximately 1" x 1" x 1" pieces of styrofoam were left in the tank for six weeks
- pH, nitrate, nitrite and ammonia were measured using an API® Freshwater aquarium master test kit, which includes aqueous color changing solutions and a color chart to determine nutrient and pH levels weekly.
- Molecules tested since plastics have been shown to change the pH of the water and salinity via breakdown of molecules and addition of nitrates, nitrites, and ammonia (Shah, Hasan, Hameed, & Ahmed, 2008).
- The statistical analysis comparing the levels of salinity, pH, nitrite, ammonia and nitrate in the two tanks was conducted via a two-tailed t-test.

Results

- Salinity, pH, Nitrite, Ammonia, and Nitrate are compared for control and Nitrate are compared for control and experimental groups. All of the p values were measured by t-tests with a 95% confidence interval

	Control	Experimental	P value
Salinity	34-43	34-43	0.58
pH	8.15	8.30	0.0071
Nitrite	0 ppm	0 ppm	-
Ammonia	0.12 ppm	0.12 ppm	1
Nitrate	1.67 ppm	1.75 ppm	0.84



Graph 1: Changes of pH in both control tanks over a six week period.

- Film was found at the bottom of the experimental tank, and when observed at 5x magnification it was found to be microplastic buildup.
- Our buildup (pictured left) was compared with a known microplastic image (pictured right) and was found to have a similar structure

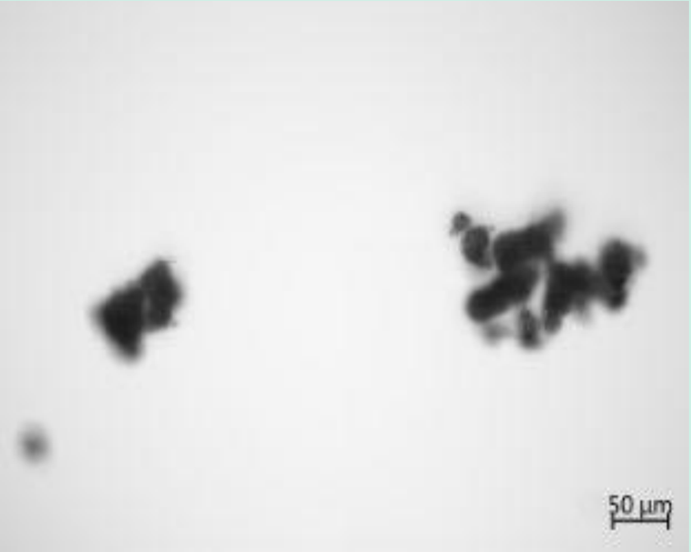


Figure 1: Image of particulate taken with a Zeiss Axio Imager at 20x magnification.

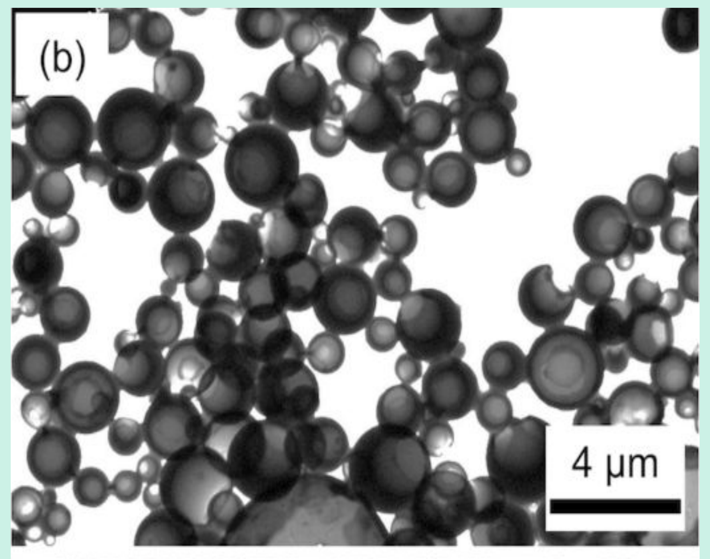


Figure 2: Polystyrene Morphology (Takahashi Y, 2018)

Discussion

Figure 1 depicted the particulate from the experimental tank obtained from the Zeiss Axio Imager, exhibiting a fibrous network similar to literature findings of polystyrene particulate. *Figure 2* exhibited polystyrene findings from the Takahashi experiment, revealing a spherical structure and shape in which *Figure 1* matched with. The images concluded that said particulate findings resulted from the physical breakdown of styrofoam into polystyrene.

Conclusion

Minimal ocean chemistry changes, film of particulate on the bottom of the experimental tank analyzed to be polystyrene based off structure
In the Future we plan to test the effect of microplastic in direct environment of brine shrimp by Exposing shrimp in two environments: normal and infused with styrofoam to target polystyrene and use other organisms holding a larger impact on food chain, such as mussels

Our Plan

For this semester, we had planned to take our previous results pertaining to the speed of microplastic breakdown and apply them to further investigate the effects of microplastics when ingested by marine organisms. We had planned to set up an experimental tank in which ghost shrimp were living in water that was infused with microplastics. Using bioluminescent dye, we would have observed the shrimp under UV light to track the buildup of microplastics in their bodies and compare those results with a control set of shrimp. We did not complete this experiment due to disruptions caused by COVID-19, though we did begin the process of assembling the materials needed. We expected to see that the polystyrene would bioaccumulate and we would find micro plastic within the tissue of the shrimp via the luminescent dye as had been seen with brine shrimp and other types of plastic.

Citations

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