Me, My Clothes and the Ocean: The Role of Our Clothes in Microplastic Pollution

De Humanitate

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Abstract

Living on the west coast of Canada, microplastics are a visible and significant environmental issue. One may be conscious of the nearby marine ecosystems, but not of the impact microplastics from consumer activities have on them. Knowing how something as simple as washing clothes impacts the environment will allow people to begin implementing a change of behaviour. It is expected that the levels of microplastics in the washing machine water will increase substantially after washing textiles, such as polyester and other synthetic materials, that contain microfibers. This project will entail testing and documenting the levels of microplastics that are released when washing textiles and researching the effects that it has on marine wildlife around coastlines. Requirements for this project include access to washing machines, a variety of different fabrics and a vacuum filtering set to measure the levels of microplastics in water after washing. It is expected that once the project is completed, members of the community will have an understanding of the harmful and long-term implications of microplastics.

Keywords

Acrylic, bioamplify, filter feeder, synthetic, microfibre, microplastic, nylon, polyester, textile.

1 Introduction

The threat of microfibres in waterways, oceans, and lakes is becoming more well-known to the public. There has only been moderate research about this growing issue and there have been even fewer proposed solutions. Microfibres are usually defined as fibers that are <5mm (Plastic microfibre ingestion by deep-sea organisms) that bioamplify, meaning their toxins absorb into the flesh of various individuals in the food chain. According to a paper published by the Vancouver Aquarium, between 9,777 and 4,315,371 microfibers are shed per kg of textile per wash (Me, My Clothes, and the Ocean). These are clearly massive numbers, but what are the actual effects of all these microfibres in waterways and wildlife? How many effects remain unknown? Considering that the majority of the human population wears clothing mass produced by corporations that use synthetic fibers to make these clothes, these numbers are multiplied even further. Through more research and educating others, advances can be made in reducing the impact of microfibres.

It is important to distinguish between the relative sizes of microplastics and microfibres. Microplastics are typically referred to as less than 5 mm in size. A microfibre is a type of microplastic that is fibrous in composition. Microfibres can be particularly harmful due to their ability to be ingested by living organisms. As stated in a paper by the University of Victoria, an adult male person can ingest up to 60,000 microplastic particles annually (Human Consumption of Microplastics). Microplastics with a diameter less than 130 µm have the potential to end up in human tissue and release toxins produced in plastic production. The effects on human health are currently being studied. Likewise, there is little research available on the individual impacts microplastics have on marine organisms; however, new research is underway. Microplastics have been found in the intestines of a baleen whale (Microplastic in a macro filter feeder: Humpback whale Megaptera novaeangliae). Other filter feeders, such as basking sharks and clams are quite possibly undergoing a similar fate.

A variety of garments will be tested to measure the numbers of microfibres shed per wash. By using clothing from popular brands an impact can be made on community members, as this attire is worn by many. Nylon, two types of polyester, and acrylic will be tested.

It is difficult in this day and age to purchase clothing that do not contain plastic fibres, such as polyester or nylon. By educating the local community about the striking effects of microfibres, a noticeable change can be made due to the consumer refusal of clothing companies that produce synthetic garments.

2 Methods

2.1 Textile Washing

Testing of the amounts of microplastics shed from certain types of synthetic fabrics under certain conditions occurred from February to March 2020, and was cut short due to COVID-19. Team members were unable to meet together, and the testing required multiple people to work together at the same time. The content of this paper contains what was able to be completed before the pandemic, as well as some research that could be done remotely.

Filter paper was weighed using a scale in order to determine an initial mass value, measured to the second decimal place. The filter paper was placed onto the top of the vacuum filtering set. Fabric was cut into 6 inch squares and placed in a manually operated washing machine. Fluffy polyester, normal polyester, nylon, and acrylic fabrics were used. Each type of fabric was a different colour, in order to be able to discount any stray fibres left behind. 350 mL of water was poured into the washing machine. 5 degree, 20

degree, and 30 degree water was used. The washing machine was run for one minute per trial.

Washing Machine

After one minute had passed, the water was poured from the washing machine to a beaker with a connected tube. The beaker was poured into the top of the vacuum filtering set. The apparatus was pumped so that the water would flow through the filter paper into the erlenmeyer flask below it, leaving the plastic microfibres from the water on top of the filter paper. Once most of the water was removed from the filter paper, it was placed in an incubator for several hours to dry out.

Vacuum Filtering Set

Once dry, the filter paper was carefully placed on top of the scale, and its mass recorded. The difference between the final mass and the initial mass was the mass of microplastics shed from the fabric. The procedure planned for 54 squares of each fabric type to be tested with the variables of temperature, duration, and whether or not detergent was used. Unfortunately, not enough samples were tested prior to COVID-19 in order to produce sufficient results.

2.2 Microfibre Knowledge Survey

A survey was conducted amongst a wide variety of students at Oak Bay High School on March 13, 2020. Twenty-five students were quizzed on their knowledge of microplastics, and synthetic textiles. They were asked how many tonnes of plastic microfibres are shed from households in the United States and Canada every year, whether or not synthetic textiles shed plastic microfibres, if natural textiles shed microplastics or microfibres, and were asked to reflect on the types of fabrics their clothes were made from in their households. Random homeroom groups of students were chosen. Each homeroom included a variety of students from grades 9 to 12. The survey consisted of four multiple choice questions in a paper format:

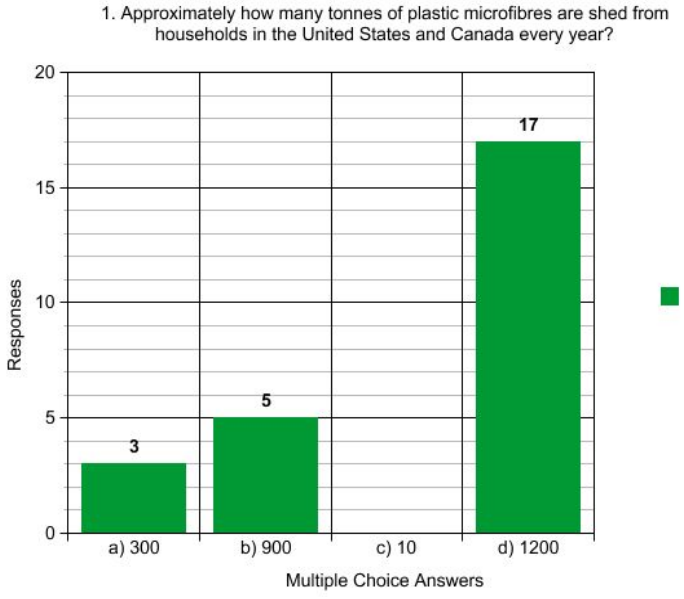
3 Results

3.1 Textile Washing

Due to COVID-19, the testing was unable to be completed and there are insufficient results.

3.2 Microfibre Knowledge Survey

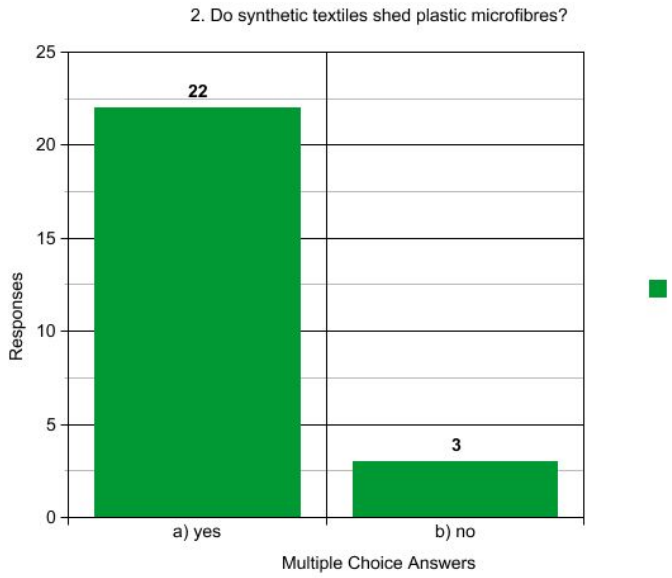
Fig. 1



Correct answer: B

20% of students selected the correct answer for this question.

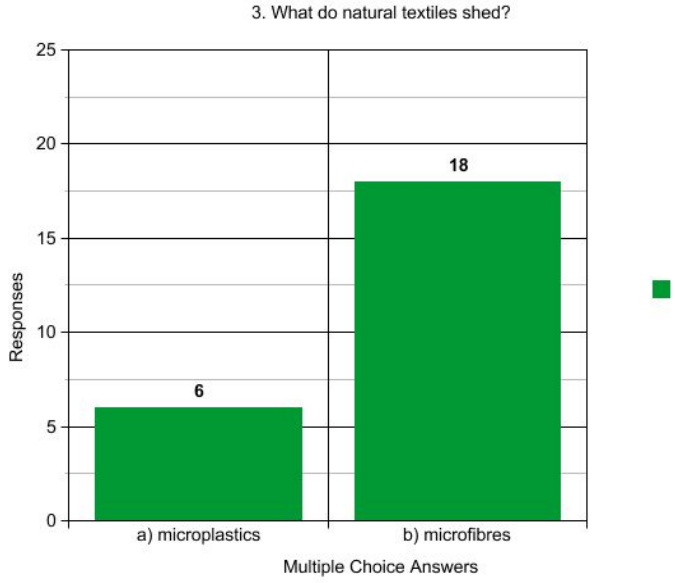
Fig. 2



Correct answer: A

88% of students selected the correct answer for this question.

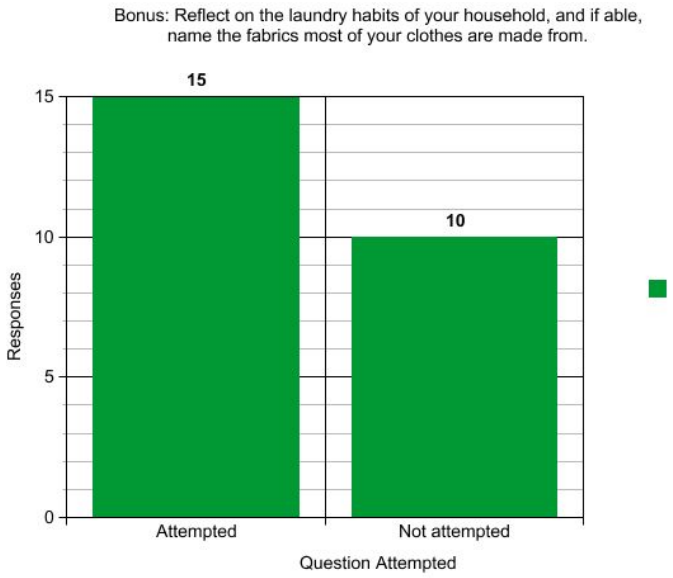
Fig. 3



Correct answer: B

75% of students selected the correct answer for this question. One student left the question blank, which is why there were only 24 responses.

Fig. 4



Correct answer: B

60% of students decided to answer the bonus question, and provided information on what materials their clothing was made from.

4 Research

Due to their small size, the dire impacts that microplastics have on aquatic ecosystems are often overlooked. The organisms most affected by microplastic pollution are those at the bottom of the food chain, and filter feeders. Filter feeders are organisms that obtain nutrients by straining water through a filtering structure, and capturing the microorganisms inside. Examples of filter feeders are whale sharks, manta rays, and baleen whales. Along with other organisms, filter feeders can end up consuming microplastics. Many filter-feeding species live in extremely polluted areas. They can consume over a thousand cubic metres of water per day; therefore they are more susceptible to consuming microplastics than other organisms. Having consumed microplastics, filter feeders are often unable to absorb nutrients. Their digestive systems can be blocked, and the toxins in the microplastics are absorbed into their flesh. This can have harmful repercussions over time.

(Microplastic pollution in world's oceans poses major threat to filter-feeding megafauna)

The impacts of microplastics on human health are beginning to be researched. A study done by the Vancouver Aquarium (Human Consumption of Microplastics) showed that American adults consume and inhale between 98,305 and 121,664 plastic particles per year. Children can intake 74,060 to 81,331 microplastics annually. These values differ based on caloric intake, gender, and age. Most of these particles are inhaled, the second most common source

is from bottled drinking water, and after that, seafood. This would suggest that humans could absorb the same toxins from plastics that marine organisms do, leading to adverse effects in their health.

5 Discussion

5.1 Discussion and Results

Due to COVID-19, the textile testing was unable to be completed and there are insufficient results; they cannot be properly discussed.

80% of students got the first question wrong. 68% selected answer D: 1200, while 20% selected answer B: 900. It is likely that those who selected "D" were expecting the answer to be a large sum.

For question 2, 88% of students selected the correct answer. This result is either due to the prior knowledge students had, or random guessing. Question 3 had a similar percentage of correct answers (75%), likely due to the same reasons.

60% of the students chose to answer the bonus question. The question was: Reflect on the laundry habits of your household, and if able, name the fabrics most of your clothes are made from. 13 students said that their clothes were made from cotton, and 5 students said their clothes were polyester or synthetic. One student said their clothes contained nylon. One student mentioned wool. One student displayed the knowledge that when they wash clothing, microfibres can enter bodies of water.

5.2 Potential Sources of Error

Although the fabric testing couldn't be completed, potential sources of error can be identified. The washing machine used was unwieldy at times, resulting in some water spills and leaks. It was difficult to remove all the water after a cycle. Likewise, there were sometimes fibres left behind that were difficult to remove. There may have been some fibres that remained for the subsequent cycle, and were counted for the wrong cycle.

The scale used measured the mass of the filter paper and fibres shed to the second decimal place. A more precise scale may have been more ideal for such small masses of plastic.

In the future, a short answer format may be more ideal for the survey. It would produce more accurate results of what knowledge students have on microplastic pollution, because they would reflect on what they know already, instead of selecting what they deem to be the most likely correct answer. A larger sample size of students would be used.

5.3 Next Steps

Future students would repeat the same procedure, ideally with a better washing machine and more precise scale. The aim would be to determine which fabrics release the most microplastics, and which washing conditions (temperature, duration, intensity) could mitigate their release. The results collected will be used to produce a presentation to educate the local community about the negative impacts that microplastics shed from clothing have on the environment. This section could focus mostly on local ecosystems and organisms.

The research component could delve deeper into the impacts of microplastics on human health. A focus could be made on the microplastics consumed by humans from eating seafood products. It would be interesting to see if humans with a plant-based diet consumed less microplastics than those who eat seafood or land-animals.

6 Conclusion

This project will serve as a baseline for future students to research the role that clothing plays in microplastic pollution. It can also be expanded upon by future students to be used as an education tool.

7 Acknowledgments

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