Quantifying and Analyzing Microfiber Pollution in Great Lakes Sediment near *Cladophora* Mats

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Abstract

Microfiber pollution is ubiquitous in aquatic environments. Synthetic microfibers, a major class of microplastics, such as polyester, rayon, acrylic, and nylon, are present in clothing and other textile items, and are now viewed as contaminants of emerging concern. Routine laundering of synthetic fabrics has contributed to massive microfiber contamination in surface waters. In addition to its presence in water and sediment, previous microfiber research by our group showed that Great Lakes *Cladophora*, a common macroalgae, entangles and adsorbs microfibers in much greater amounts. This research aims to assess the role of the lake sediment below and near *Cladophora* mats in the fate of these microplastics. To determine if this sediment traps synthetic microfibers, research was conducted with sediment samples collected by the United States Geological Survey (USGS). Samples were cleaned using a $ZnCl_2$ solution for density separation, which suspends most microfibers from the heavier sediment. All samples were then subjected to an advanced oxidation technique, which generates hydroxyl radicals that decompose most natural organic materials, including natural fibers. Microscopic analysis was implemented to quantify synthetic microfibers. The early analyses indicate that the lake sediment does not have entanglement or adsorbent properties. Due to the ubiquitousness of microfibers, method blanks were implemented to determine the amount of microfiber contamination introduced in the lab and suggest some work is still needed to reduce external contamination. A range of 0 to 12 microfibers (Av = 7) have been found in the samples per average dry weight of 32.152 g.

Background

- Microfibers are released into surface waters through the laundering of synthetic textiles.
- Previous research by our group concluded that significant amounts of microfibers entangle and adsorb to *Cladophora* algae.
- As an extension of this work, we are investigating the fate of synthetic microfibers after algal senescence.
- USGS researchers collected sediment samples from below and near *Cladophora* mats.

Figure 1. USGS scuba diver collecting *Cladophora* algae samples (photo provided by USGS).

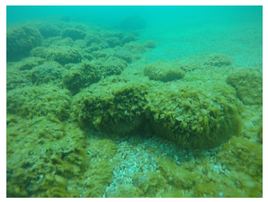

Figure 2. *Cladophora* mat within the Great Lakes.

Figure 3. Microfiber found within *Cladophora* sample.

Results

The early stages of this work suggest that the lake sediment does not trap the synthetic microfibers to the same extent that the *Cladophora* algae does. 12.5% of the observed filter papers (3 out of 24) contained no microfibers. Each of the clean filter papers were isolated from a unique sediment sample.

Figure 4. Stereomicroscope images of microfibers found within sediment samples collected by the USGS.

Our previous *Cladophora* research concluded that synthetic microfibers loads ranged from 100-10,000, or 2 - 4 magnitudes higher than our earlier watershed research of water and sediment samples. We expect that the Great Lakes sediment, much of which is sand and rocks, does not have entanglement or adsorbent properties to collect and hold synthetic microfibers.

Figure 5. Map displaying a sampling area for *Cladophora* research in Leland, Michigan.

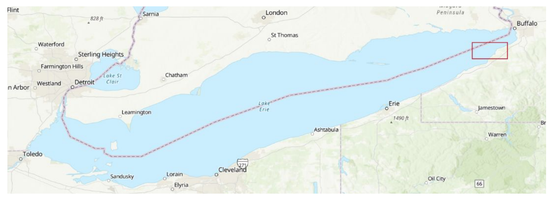

Figure 6. Map displaying a sampling area for *Cladophora* research in Lake Erie.

The ubiquitousness of synthetic microfibers in the environment around us has caused some difficulties in this research and some work is still needed to reduce external contamination.

Methodology

- Density separation (Figure 4) was used to separate microfibers, which suspend or float, from sediment that settles.
- H_2O_2 and UV radiation (Figure 5) produced hydroxyl radicals to decompose much of the natural organic matter.
- Oxidized mixtures were filtered to isolate synthetic microfibers and quantify them with a stereomicroscope (Figure 6).
- Extra precautions were taken to prevent microfiber contamination in the lab:
  - Method blanks were implemented to quantify contamination.
  - Glassware was rinsed with deionized water and covered with aluminum foil.
  - 100% cotton lab coats were worn to reduce contamination.

Figure 7.

Figure 8.

Figure 9.

Conclusions

- Early analyses indicate that lake sediment does not have entanglement or adsorbent properties to collect synthetic microfibers.
- Many additional Great Lakes sediment samples will be processed and analyzed for synthetic microfibers.
- We plan to process and analyze shoreline sand samples from Indiana Dunes to further understand the distribution and fate of plastic microfibers.
- More research is needed to better understand the fate of synthetic microfibers within the Great Lakes

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Peller J, Nevers MB, Byappanahalli M, Nelson C, Ganesh Babu B, Evans MA, Kostelnik E, Keller M, Johnston J, Shidler S. Sequestration of microfibers and other microplastics by green algae, Cladophora, in the US Great Lakes. Environ Pollut. 2021 May 1;276:116695. doi: 10.1016/j.enpol.2021.116695. Epub 2021 Feb 10. PMID: 33601201.