Examining Synthetic Microfiber Waste Through Laundry and Potential Mitigation Strategies

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Abstract:

An emerging area of urgent environmental concern is synthetic microplastic pollution in marine and freshwater environments. These pervasive plastic particles never completely degrade and have serious impacts on the health of organisms, including humans. Synthetic microfibers make up 35 percent of microplastic waste and are formed from machine washing synthetic clothing. The purpose of this study was to investigate the presence of microfibers in three rivers of the Hudson River watershed as well as study the usage of two microfiber filters available for household washing machines. The investigation of microfibers in the Hudson River watershed consisted of retrieving water samples from the Black Creek, Wallkill River, and Saw Mill Brook in Ulster County, New York. These water samples were filtered and viewed under a microscope in search of microfibers. Microfibers were found in each of the water samples, with the Saw Mill Brook containing the most microfibers per quart of sample water. Researching the usage of microfiber filtration technologies consisted of installing two microfiber filters, *Lint-Luv-R* and *Filtrol*, onto two laundry machines in McKenna and Parker Theaters on the campus of SUNY New Paltz. Data was collected regarding the consumer usage of each filter, which included the price, installation, efficacy, and cleaning. Based on these evaluations, the *Filtrol* was regarded as the better filter for home and campus use.

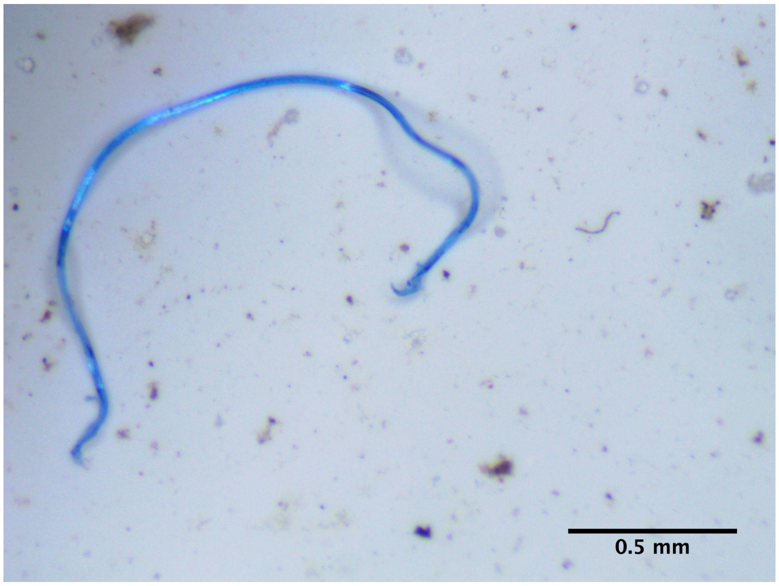
Keywords:

Geology	Earth Science	Microfibers
Microplastics	Synthetic Clothing	Laundry

The Microplastic Problem:

Microplastic pollution in marine and freshwater habitats is an emerging area of urgent environmental concern. Microplastics are small pieces of plastic ranging from five millimeters to microscopic lengths, and this form of plastic pollution is found in waterways and oceans across the world. Research of microplastics is emerging, but researchers generally classify microplastics into three sub-categories: primary, secondary, and microfibers. Primary microplastics are plastics which are designed and manufactured to be small. These include microbeads, which were found in many cosmetics, as well as plastic pellets, which are used to create larger plastic items. Plastic microbeads have been banned in the United States through the Microbead-Free Waters Act of 2015, which prohibits the manufacturing, packaging, and distribution of cosmetics containing plastic microbeads. When scientists realized these microbeads were harming aquatic life, legislation was enacted to prevent further damage. Unfortunately, similar legislation is not as easily imposed on the other two sub-categories of microplastics. Secondary microplastics form as a result of the physical and chemical breakdown of larger plastic waste, which creates randomly shaped fragments and films of plastic. Wave action and UV light continually batter plastic items into smaller and smaller pieces, forming microplastics. Microplastics, in fact, make up 94 percent of the estimated 1.8 trillion pieces of plastic debris in the Great Pacific Garbage Patch. (*Garbage Patches | OR&R's Marine Debris Program*, 2022)

While we have all seen the plastic bottles, bags, and straws that contribute to the plastic pollution problem, another major source of plastic pollution is less obvious: our clothes. Most of the clothing on the planet is made from synthetic, plastic-based materials such as polyester, nylon, and acrylic. When washed, synthetic clothing sheds tiny plastics known as microfibers, which are thread-like forms of microplastics. An average of 9 million microfibers are released in a single load of laundry. (*Clean Laundry, Dirty Ocean!*, 2022) Microfibers exit the washing machine through the greywater outlet, continue down the drainpipe, and make their way to the local sewage treatment center. Most industrial sewage treatment systems receive too much volume of water to effectively filter out the microfibers so much of the microfiber pollution ends up in the waterway where the treated water is released. Because of this, microfibers are encountered in marine and freshwater environments as well as in the tissues of shellfish and other aquatic life. There is an ever-expanding body of scientific literature studying the impacts that microplastics have on aquatic organisms and the organisms that consume them (including humans). Data on the presence of microplastics in large rivers - including the Hudson River - remains relatively scarce, and local data needs to be contributed to the larger body of evidence.



Microfiber viewed under a microscope, Carey, 2017

Previous research had determined humans ingest and inhale microplastics on a daily basis, but recently, microplastics have been discovered in human blood. This was the subject of various news articles in March 2022 which cited a study from the

Netherlands stating, “plastic particles were found in the blood of more than three-fourths (17 out of 22) of the Netherlands-based donors who participated in the study.” (Snider, 2022) Once in the blood, microplastics have the potential to negatively affect human health because they can contain and harbor toxic chemicals. According to a research article on the effects of microplastics on human health, “microplastics can contain two types of chemicals: (i) additives and polymeric raw materials originating from the plastics, and (ii) chemicals absorbed from the surrounding ambience.” Chemicals addicted to plastic products “include inert or reinforcing fillers, plasticizers, antioxidants, UV stabilizers, lubricants, dyes and flame-retardants.” (Campanale et al., 2020) In addition, microplastics tend to bind with pollutants in the environment such as pesticides and heavy metals. Many of these chemicals are considered carcinogens or endocrine disruptors and can disrupt the normal functioning of the human body. For example, “the ability of nanoparticles in polystyrene to cross the placental barrier” was demonstrated. (Campanale et al., 2020)

Current Mitigation Strategies:

Microfibers are an extremely pervasive form of microplastic pollution in our waterways, and because of their detrimental effect on aquatic life, researchers have been actively looking for solutions. Based on the most recent research, there are a few strategies that strive to mitigate our individual microfiber footprint. The first and most aggressive form of mitigation is the installation of an external microfiber filter on a washing machine. While the washing machine is running a load, these devices divert the discharge water through a specialized filter which removes the microfibers, and other solid debris, before allowing it to continue down the household drainpipe. The filters are completely reusable, though after 10 - 15 loads, the filters need to be cleaned by depositing the microfibers into the trash, not down the drain, which is the best way of disposing of microfibers to date. These filters are primarily designed to reduce the number of microfibers heading into our waterways, but the filtration of washing machine discharge water also helps to prevent septic backup and failure. The two most well-known microfiber filters are the *Lint-Luv-R* and *Filtrol*. These filters cost $150 and $160 respectively.

Retrofitting a washing machine with a microfiber filter may be a daunting, and expensive, task for some consumers. Luckily, there are in-laundry microfiber catchers for a more portable option, especially for those who do not have a permanent washing machine, such as college students or those living in an apartment. The first is the *Cora Ball* which is a small microfiber catcher inspired by the filtration action of coral and goes into the washing machine with your clothes and works to filter out microfibers. According to the company, one *Cora Ball*, at $39, catches 31 percent of microfibers. The company suggests purchasing three for $110 to achieve a 93 percent reduction in microfibers. Another easy option for reducing microfibers is using a wash bag for synthetic and blended synthetic clothing. These wash bags are specifically

Cora Ball, coraball.com

designed with a small pore size to capture microfibers. *Guppyfriend* is the name of one of these wash bags and the company says its $35 bags capture 90 to 100 percent of microfibers. Laundry bags are a good option for those who frequent the gym or pool and need to wash a smaller amount of synthetic clothing often.

In addition to these forms of microfiber mitigation, making a few, simple changes to laundry practices offer microfiber reduction immediately and at no cost. First, wash less often. Most articles of clothing do not need to be washed every time they are used, and there are simple, more natural methods of freshening up clothing between washes, such as hanging outside. The UV light from the sun will kill much of the bacteria on the surface of the clothing, providing a fresh, clean scent. When it's time to wash clothing, make sure to wash a full load. Microfibers are released because of the high-frictional environment in the washing machine, so having more clothing in the machine will reduce the amount of abrasion between the clothes. Separating clothing based on weight, such as heavy jeans and jackets versus light shirts, hand towels, and underwear, also reduces the amount of abrasion in the washing machine. When choosing between all the settings on the washing machine, select the quick wash cycle with cold water, this will be less aggressive on the clothing. Lastly, start to wear more natural clothing such as cotton, linen, hemp, and wool. It may be more expensive, but buying high quality, organic clothing will last much longer than anything synthetic, which reduces the number of times you need to purchase new clothing. Buying second hand, durable products is a way of working around the price barrier. As an avid hiker, I used to only purchase synthetic clothing for outdoor adventures, it's what I was taught and it's what everyone else was doing. Once I started to learn about the synthetic microfiber issue, however, I began to realize that my decisions were negatively impacting the environment. Releasing so many synthetic microfibers was not something I could stand for, so I began to shift my hiking wardrobe toward more natural materials: organic cotton pants and shirts, wool and hemp hiking socks. It felt good to go ‘back to the basics’ and the natural clothing, in my opinion, has proven several times more durable, warm, and breathable than synthetics. I was able to afford this high-quality clothing by purchasing them second hand, and because the clothing is durable, I won’t have to purchase more for a long time. The question of hiking and outdoor sports clothing always comes up because people are conditioned to believe that synthetics are the best. Stores are full of synthetic clothing and the saying “cotton kills” cycles throughout the hiking community. Taking a step back and shifting towards purposeful, natural clothing for outdoor wear is something that I’m trying to spread.

Microplastics in our Region:

Although research into the presence and extent of microplastic and microfiber pollution in New York waterways is emerging, data on this environmental issue has yielded concerning results. Abigail Barrows, a marine research scientist, along with a team of researchers, measured microfiber pollution across all 13,300 miles of the Hudson River. Using a surface grab sampling method, the team was able to find one microfiber per liter of sample water. (Carey, 2017) “Extrapolating from this data, and using available hydrographic data, the Hudson River contributes an average of 300 million microfibers into the Atlantic Ocean per day.” (Miller et al., 2017)

Another study by Jacqueline Smith, from the geology department of Union College in Schenectady, NY, included a mesh trawl sampling method of 21 Mohawk River tributaries and the Mohawk River main channel in Rome, NY. The results of the study found “microplastic particles in all of the samples collected in the tributaries and in the sample from the Mohawk River in Rome.” (Smith et al., 2020)

These studies prove the presence of microfibers in the Hudson River and the Mohawk River including its tributaries. After reading these articles, I was inspired to incorporate my own element of field research - investigating our local Hudson River tributaries for microplastics and microfibers.

Sampling Local Waterways for Microplastics:

On November 1, 2021, I retrieved my first water sample from the Black Creek where it flows under State Route 299. I used the surface grab sampling method with a two-quart container. According to Abigail Barrows’ study, the surface grab method is more accurate than the mesh trawl method because some microfibers can escape through the mesh with the trawling movement. (Carey, 2017) On November 8, 2021, I retrieved a two-quart sample from the Wallkill River at Sojourner Truth Park and another sample from the

Sampling the Wallkill River, 11/8/21

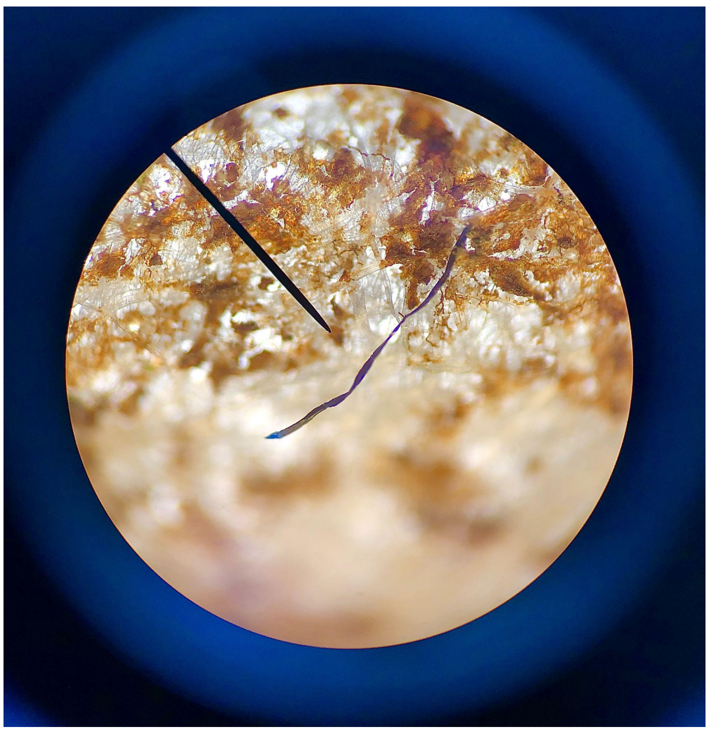
Saw Mill Brook also at Sojourner Truth Park. Both samples were retrieved using the surface grab method.

In the beginning of April 2022, I began to design a method of separating the solid matter from the water in each of the samples so I could view and potentially identify any microplastics using a microscope. I designed a no cost separation system which consisted of a gallon plastic container, a standard coffee filter, and funnel. The coffee filter was pushed into the neck of the gallon container and the funnel was used to pour the sample water through the coffee filter and into the plastic container. On April 6, 2022, I poured one quart of each sample through three different coffee filters. I could see all the solid debris getting caught in the filter, so I considered my design a success. After pouring, I set the dirty coffee filters aside to dry. The entire separation process took about one hour to complete. I believe it is worth mentioning that the three samples were at a variety of conditions upon opening. This was the first time I had closely observed the relative conditions of each sample. It was clear that the main Wallkill River sample was the dirtiest. The water was silty, and the sides of its container had turned brown with algae or biological growth. The Black Creek sample was in better shape than the Wallkill River. The Black Creek sample water was less silty, and no growth had occurred on the sides of its container.

Separation system, 4/6/22

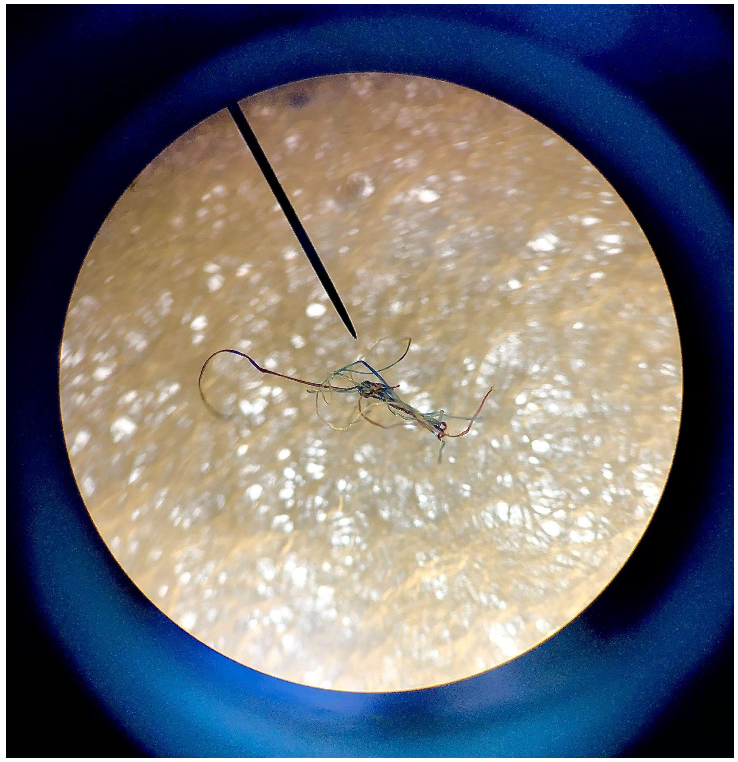
The cleanest of the samples was the Saw Mill Brook sample. This sample had the least silt and no growth on its container. Seeing that the Saw Mill Brook sample was the cleanest was a positive discovery for me. It is, in fact, that this brook is the waterway which directly connects the lakes, including the surrounding watershed, on SUNY New Paltz campus down into the Wallkill River.

On April 24, 2022, I observed the samples under a compound microscope in search of microfiber pollution. Using the 40x magnification scanning objective lens, I was able to survey the surface of the coffee filter. To my surprise, I located several microfibers in each of the samples in a matter of seconds. I was able to tell the strands I was observing were microfibers because of their plastic sheen, translucent opacity, and bright color. I collected data on the number of visible microfibers on each sample which resulted in 8 microfibers per quart in the Black Creek, 10 in the Wallkill River, and 14 in the Saw Mill Brook. I then used the 100x magnification lens to closely observe and photograph some of the individual microfibers. Most of the fibers were half a millimeter to a millimeter in length. I also found two bundles of microfibers where multiple individual fibers became entangled.



Microfiber from Saw Mill Brook, 100x, 4/24/22

This study, although limited, proved the presence and pervasiveness of microfibers in our local waterways. Multiple microfibers were present in just one quart of each sample. The data from this study will be sent to Riverkeeper, a non-profit environmental organization which works to protect the Hudson River and its tributaries. The results from my investigation pushed me to research the most effective way of stopping microfibers at the source - external microfiber filters - to reduce the number of these plastics from entering our waterways.



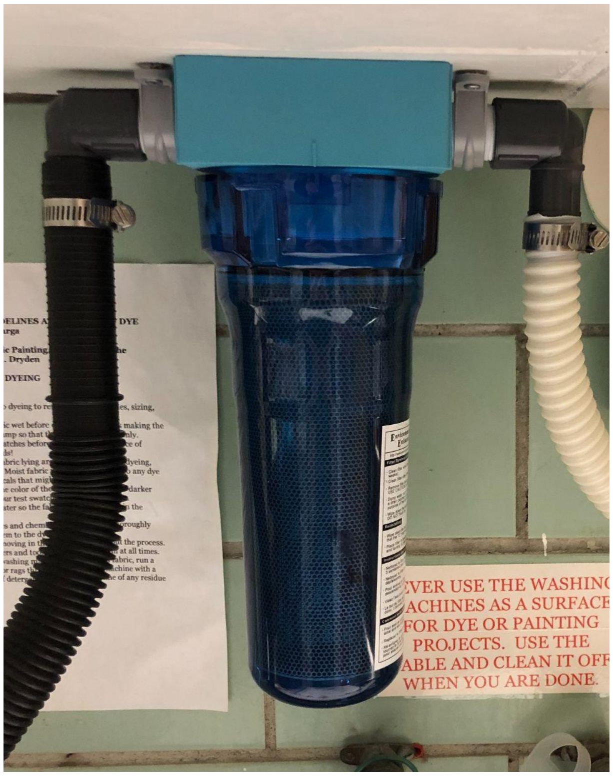
Microfiber bundle from Saw Mill Brook, 40x, 4/24/22

External Microfiber Filters:

One of the most effective ways of reducing the number of microfibers released in the laundry is installing an external microfiber filter on a washing machine. Two of the best-known microfiber filters are the *Lint-Luv-R* and the *Filtrol,* as previously mentioned. In the fall of 2021, I received both filters through an AYURE (Academic Year Undergraduate Research Experience) grant and installed them on campus.

***Lint-Luv-R*:**

The *Lint-Luv-R* is manufactured by the Canadian company, Environmental Enhancements. The purpose of the filter is to remove lint and microfibers from washing machine discharge water. The washing machine discharge hose attaches to the inlet port on the side of the filter. Lint collects on the outside of the filter screen and the treated discharge water is directed from the outlet port into the household drainpipe. The *Lint-Luv-R* costs $150 for the complete filter with the necessary attachments for installation underneath a shelf. Installation of the *Lint-Luv-R* in the Parker Theater laundry room was relatively straightforward, only requiring basic household tools. One problem during installation was that the provided hose to connect the filter’s outlet port to the drainpipe was unable to bend even slightly without kinking it. This rendered the hose almost unusable for our laundry space situation which required the hose to bend to fit between the outlet port and drainpipe. I resolved the problem by using a section of the hose provided by the *Filtrol* filter which was able to bend freely.



Lint-Luv-R installed in Parker Theater, 1/27/22

Once installed, the *Lint-Luv-R* performed as it should, filtering out lint, microfibers, and other solid debris from the washing machine discharge water. According to the company, the filter needs to be cleaned every 10 to 15 loads of laundry. Cleaning requires the detachment of the filter bowl and filter screen, which is very easy. Then you must scrape the sides of the filter screen over a garbage can to dispose of the accumulated microfibers. This would be a very simple cleaning process except the filter bowl is full of water concentrated with microfibers and other debris, and there is too much water to put in the garbage can and releasing it down the drain would defeat the purpose of the filter. I looked on Environmental Enhancements' website and saw that they sell a separate mesh cleaning bag to pour the filter bowl water through during cleaning. This separate purchase for the cleaning process is a downside of the *Lint-Luv-R* filter.

Lint-Luv-R filter screen after 10 loads, 4/5/22

According to the company, the filter screen has a pore size of 1580 microns, about 1.6 millimeters. Given that most of the microfibers I found in the local waterways were 1 millimeter or less, I assume this filter is good at filtering out the larger sized microfibers, but less effective for the average sized microfibers.

Filtrol:

The *Filtrol* filter is manufactured by a Minnesota company. The purpose of the filter is to remove microfibers and other solid debris from the washing machine discharge water. The washing machine discharge hose attaches to the inlet port on top of the filter. Water is sent through a mesh filter bag before draining through the outlet port at the bottom of the filter. The *Filtrol* costs $160 for the complete filter with the necessary attachments for installation on a wall or side of a shelf. Installation of the *Filtrol* in the McKenna Theater laundry room was, again, relatively straightforward, only requiring basic household tools. The provided hose to connect the outlet port to the drainpipe was superior to that of the *Lint-Luv-R* as mentioned before. During installation, the washing machine needed a new drain hose because the original hose would not fit the filter's inlet port. This was not the fault of the *Filtrol* because the original drain hose was cut at the end which did not make it a standard size. I installed a new drain hose on the washing machine, and it fit the inlet port perfectly.

Filtrol installed in Mckenna Theater, 3/1/22

It is worth noting that the lid of the *Filtrol* filter arrived with a small crack, perhaps from a drop during shipping or just a defective part. I did not believe the crack was significant enough to inhibit the function of the filter, so I installed the slightly damaged lid on the filter. After a few weeks though, the crack grew to a point where I did not feel comfortable leaving it on the filter. I contacted the company about this situation, and they sent me a new lid quickly and without hesitation.

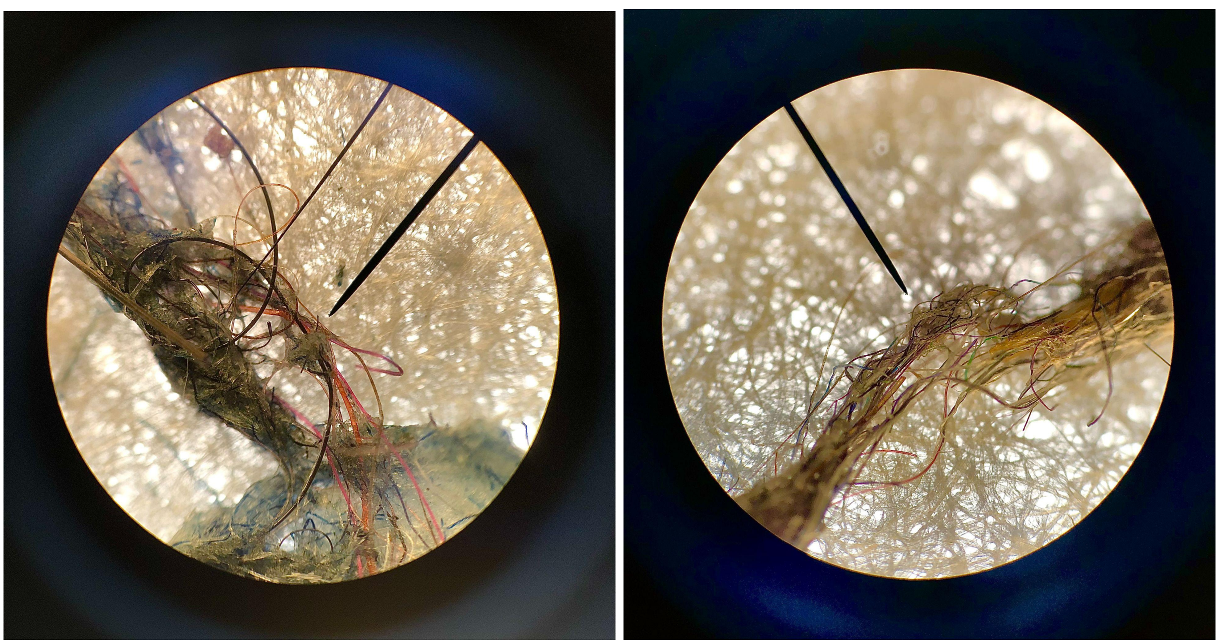
Once installed, the *Filtrol* performed well, collecting microfiber debris from the washing machine discharge. According to the company, the filter must be cleaned every 10 to 15 loads, similar to that of the *Lint-Luv-R*. Cleaning the *Filtrol* requires removing the filter lid, taking out the filter bag, then turning the bag inside out and scraping the microfiber debris into a garbage can. Unlike the *Lint-Luv-R*, the filter bowl of the *Filtrol* never contains microfibers and is constantly drained through the outlet port located on the bottom of the bowl.

Filtrol filter bag after 20 loads, 4/21/22

According to the company, the mesh filter bag has a pore size of 100 microns, 0.1 millimeters. This is much smaller than the 1.6 millimeter pore size of the *Lint-Luv-R*. Given this, I believe the *Filtrol* is more effective because it can filter out microfibers much smaller than those of the *Lint-Luv-R*.

Evaluating both filters based on their price, installation, pore size, and cleaning process, I have selected the *Filtrol* as the external microfiber filter that I would recommend for installation on campus in the future.

Spreading awareness on microfiber pollution and how to reduce our output was one of the primary goals of this project. I believe the campus and local community know more about this environmental issue due to this project and I received feedback that people would change some of their laundry habits, shift towards more natural clothing, or even buy a microfiber filter. In fact, the next step of this project is to install *Filtrol* filters on the Athletic department's washing machines on campus. Throughout this project, I kept the Sustainable Development Goals in mind, specifically goal number 14, life below water and goal number 6, clean water and sanitation.



Microfibers from *Filtrol* (left) and *Lint-Luv-R* (right), 40x, 4/24/22

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