The microscopic fibres that garments of all types shed during manufacture and laundering are now regarded as one of the most insidious forms of pollution in the world's waterways. Unfortunately for the outdoor industry, fingers are pointing to polyester fleece clothes as prime offenders. The issue is much more complex, as studies are showing.

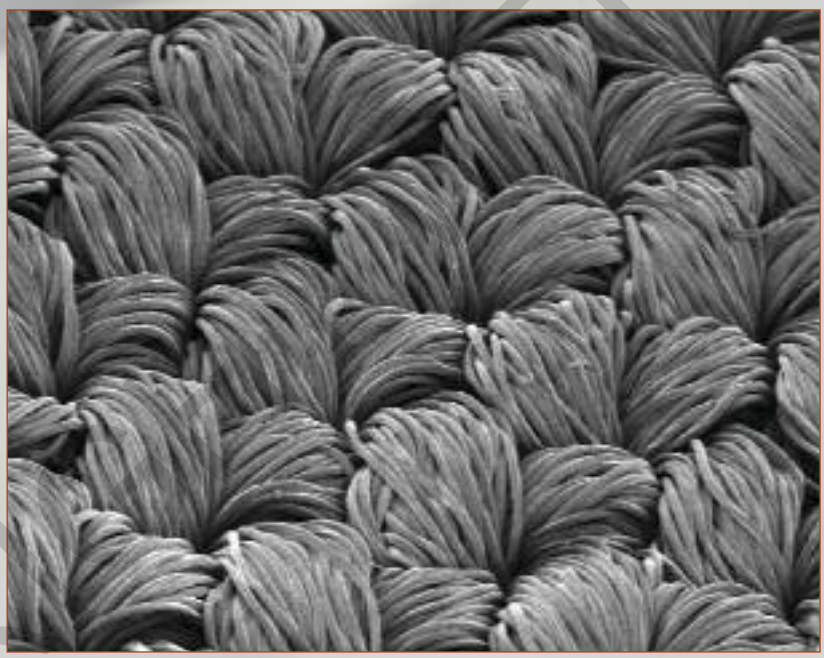
Mass microfibre migration

It's not an elephant, but an elephantine mass of tiny invisible micro strands that is tarnishing the tidy, sustainability-embellished room the outdoor industry has been fashioning for itself over the years.

It is believed that 85% of the human-made material found on shorelines are microfibres. Wastewater sampled from domestic washing machines have been found to release some 1,900 individual fibres off a single fleece jacket. These are some of the many findings marine biologist Mark Anthony Browne revealed in "Accumulation of microplastic on shorelines worldwide: Sources and sinks." His research, published in 2011, first brought the issue of microfibre migration to light.

In an opinion piece the *New York Times* published in November 2015, ("What Comes Out in the Wash"), he elaborates on the problem. "The presence of such fibres in the environment is particularly problematic not only because they sneak their way into the food chain, but also because they can damage the lungs of humans and animals. It's not just plastics; natural fibres, including those from cotton and flax, can also harm lung function and cause scarring." At the time, he was working at the National Center for Ecological Analysis and Synthesis in California. He is now a senior research associate at the school of biological, earth and environmental sciences of the University of New South Wales in Australia.

Other studies have since added to a growing body of evidence regarding the scale of microfibre pollution in the world's waterways. Research conducted at Plymouth University in the UK found that more than 700,000 microscopic fibres could be released into wastewater during each use of a domestic washing machine, with many of them likely to pass through sewage treatment and into the environment. A 2012 study by VU University in Amsterdam, estimated that laundry wastewater is sending some two billion synthetic microfibres per second into Europe's waters.



Weave patterns are suspected of having an impact on fibre shedding during washing. Findings published by the EU-funded Mermaids programme suggest that plain weave textures release fewer microfibres than twill textures.

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Whatever their composition, all garments are suspected of releasing miniscule fragments, but synthetic fibres are considered more worthy of impact as oil-based microplastic particles are said to attract contaminants that are normally not soluble in water. When the microplastics enter animals and plants in the aquatic environment, they can carry these contaminants with them, and they make their way up the food chain.

Wastewater treatment plants could be equipped with filters capable of trapping the tiny particles, but that would not solve the problem, as reported by a team of postgraduate students at the University of California, Santa Barbara, Bren School of Environmental Science & Management in 2016, a project supported by Patagonia. "Even fibres that are removed can end up in the environment—for example, when wastewater sludge is used in agriculture as a fertiliser," Elizabeth Ruff, one of the Bren researchers, has said. "From there, the fibres can run off into the water system."

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Adidas and designer Stella McCartney have both partnered with Parley for the Oceans to use yarns made from fishing nets. Its a move that contributes to reducing ocean plastics, but does not address the issue of the microfibres that garments shed when washed.

Adidas x Stella McCartney

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Tackling the topic

Industry organisations are taking steps to better understand the problem and find solutions. The European Outdoor Group (EOG) supports two research projects, one conducted by the University of Leeds and another by innovation lab Biov8tion. It has also formed a Microfibres Consortium, to which brands such as Berghaus, Finisterre, Haglöfs, Helly Hansen, Mammut, Norrøna, Salewa, The North Face, Alpkit and Jack Wolfskin have signed up, as well as fabric and yarn suppliers Shinkong Synthetic Fibres Corporation and Little King.

In 2015, the US Outdoor Industry Association (OIA) set up its own Microfibers Task Force, open to all stakeholders, including home appliance makers, wastewater treatment plants, academic researchers, scientists and apparel brands. It is working with marine debris specialists at the Ocean Conservancy.

In Sweden, sustainable fashion research programme Mistra Future Fashion has funded a pilot study conducted by Swerea IVF on microplastics shedding from polyester fabrics, and published its preliminary findings earlier this year. It has support from fast fashion retailer H&M, fashion label Filippa K and maternity brand Boob Design.

Most of these research projects are studying the impact of laundering, but some, such as Sophie Mather, a material futurist, and head of Biov8tion, focus on yarns. She is looking to find out what triggers fibre degradation and specifically the role that fibre fragmentation plays versus fibre pull-out during washing. This, she says, is "the yin and yang of the issue". She has begun her research by studying the impact of UV exposure on yarn degradation. "After 72 hours of exposure, there is considerable change in a polyester yarn," she says. Ultimately, she hopes that her insight will help fibre producers redesign their polymers to reduce migration during wearing and washing.

Microfibre counting

Dr Mark Taylor at the University of Leeds School of Design heads the second EOG-supported research project. In a presentation at the June 2017 Outdoor Show in Germany, he gave an update, delving into the particulars of identifying a suitable washing machine and cycle that would yield consistent and usable data. His team's early findings have shown that the number of fibres shed can vary from 120 to 700,000. "All fabrics shed some material, even after ten washes. And though the greatest fibre shed is when the garment is new, it doesn't stop throughout its use, especially with pile fabrics," he said.

Experimental results from the Bren Microplastics Project have found that when synthetic fleece sweaters and jackets are washed, an average of 1.7 grammes of microfibres are released. The analysis further showed that top-load washing machine trials had 5.3 times the microfibre shedding than front-load machine trials and that ageing of jackets increased the mass of fibres released by 1.8 times. For this study, the team conducted its experiments on four different types of synthetic fleece Patagonia jackets and one budget fleece jacket.



Garments treated with Polygiene's odour-reducing finish need to be laundered less often, the company says.

Polygiene

The Mistra Future Fashion washing study has compared different types of fibres and garment-making techniques. In one study, it washed two polyester jerseys having identical constructions, but one made in mechanically recycled polyester and the other in "virgin" polyester. The virgin polyester jersey was found to shed more than the recycled one (respectively 1,890 and 843 fibres). It also compared scissor and ultrasound-cut garments to determine whether shedding from the edges had an impact on microfibre release. Again, both samples shed microfibres, but the sample cut with scissors released a considerably higher amount of fibres than the ultrasonic cut fabric (1,927 as opposed to 890 fibres).

In its conclusions, the Swedish research team says the risk for microplastics shedding from garments is lower if fabric brushing is reduced, ultrasound cutting is applied in the cut-and-sew process, and microparticles on fabrics are removed during production stage.

A team of nanomaterial scientists at the Swiss research and innovation centre EMPA is studying the impact of detergents, water temperature and wash-cycle length on the release of microfibres. Their preliminary findings have shown unexpected results. Dr Bernd Nowack and his colleagues found that the quantity of fibres released by five different washing programmes was more or less constant and that washing detergents increased the quantity of microfibres

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released compared with washing in water alone. Washing temperature and duration of the wash cycles however were found to have no effect on the amount of microfibres released. "And for us, that was quite astonishing," says Dr Nowack. He had assumed that they would confirm the hypothesis that the longer a wash cycle lasts, the more microfibres it would release. "Unfortunately, this means that we are not yet able to explain how the released fibres are generated," he says.

Detergent maker Procter & Gamble has also investigated the issue at its Newcastle innovation centre, revealing some of its conclusions at a conference at the Outdoor Show in June. Its washing tests have shown that a polyester fleece jacket washed in a cold, quick cycle released 30% fewer microparticles compared to washing in a standard 40°C cycle. The same was true for a mixed load. For polyester performance jerseys, its research suggests that "reduced time is more important than the increased water and reduced agitation of delicate cycles," Neil Lant, in charge of fabric and home care R&D said. He concluded his presentation saying that "we still have lots to learn".

Certification and audit company SGS has launched a new service to help brands assess the amount of microfibres released from their products during domestic laundering. It says this can be used to pinpoint and compare the fibre-releasing properties of garments and can be used to assess and compare processing parameters that may affect the amount of microfibres released.

Possible solutions

The EU-funded Mermaids Ocean Clean Wash programme set out to identify a series of guidelines that the textile industry, detergent manufacturers and consumers could begin to implement in order to reduce the amount of microfibres migrating into the waterways. It published a handbook in 2016 proposing possible modifications in yarn-, fabric- and garment-making processes. These include changing fibre size (favouring larger filaments with rougher surfaces), twisting tighter yarns, slowing down the speed of weaving and knitting machines and making tighter fabric textures (it recommends plain weaves over twills for instance). At garment-making stage, it advises that clothes be washed before being sold. This would imply that cutting and sewing factories may have to invest in washing and filtering facilities.

Another section lays out recommendations for detergent manufacturers. "In our experience," the Mermaids document says, "the use of heavy-duty detergents releases more microfibres as

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they are more aggressive on fabrics. This is especially the case for powder detergents, which increase friction in fibres potentially facilitating their breakage." It therefore recommends liquid formats for all laundry products, including whitening agents. Favouring lower temperatures is another avenue of a possible reduction in fabric fragmentation. In addition to helping mitigate fibre release, it also supposes a reduction in energy consumption, it says. Mermaids research was conducted by the Institute of Chemistry and Technology of Polymers (ICTP) and the Institute for Macromolecular Studies (ISMAC), part of the Italian National Research Council, and the Spanish technological centre LEITAT.

The Mermaids programme also seeks to raise consumer awareness. For this purpose, LEITAT distributed 500 woven washing bags made from 100% cotton in Catalonia. These bags reduce friction during the washing process and, if they themselves release microparticles, they will be cotton and not synthetic, it points out.

The filter bag option is the strategy chosen by Patagonia, that intends to offer Guppy Friend laundry pouches, at cost price to its customers. Following the same line of thinking, the Rozalia Project has created a laundry accessory, the Cora Ball, that traps fibres during washing.

The need to develop safer fabrics and cleaning methods is vital, Mark Anthony Browne wrote in the *New York Times*. "The gold standard would be a labelling programme for companies to signal their ecological compliance with trust and transparency. Something as small as the label on your winter fleece could make a world of difference," he said.

Many unknowns remain

Before the industry begins to put warning labels on its fleece products, brands are demanding more information. The EOG has emphasised in a statement the "desperate need for more research in this area before we, as an industry, can begin to estimate the associated burdens of specific fabrics, production methods, and use conditions."

In a move to give a positive spin to the topic, the 2017 Dornbirn conference in Austria is organising a panel discussion on "Marine Litter – a problem turned into an innovative opportunity" that will be held on September 13.

First released in 2011, Mr Browne's article remained dormant for many years and the microfibre pollution went unnoticed. Compared to microbeads, which the cosmetic industry is phasing out, microfibres will certainly be more difficult to dispose of, yet their invisible pollution is a very real threat.

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