

# The path of a fiber ..... its transformation into microplastic

ATELIER RELARGAGE DES MICROPLASTIQUES PAR LES TEXTILES - 28 OCTOBRE 2021

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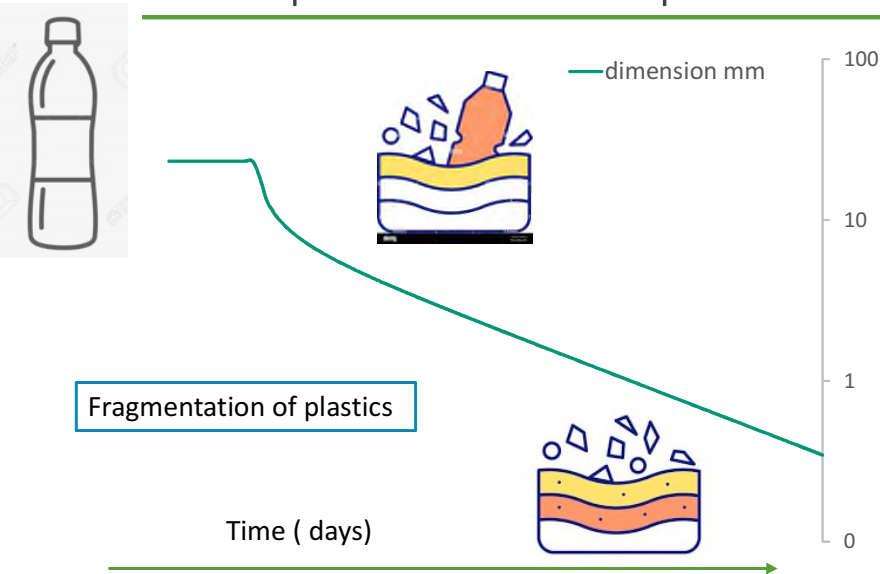
Avec le soutien du Fonds Européen de Développement Régional



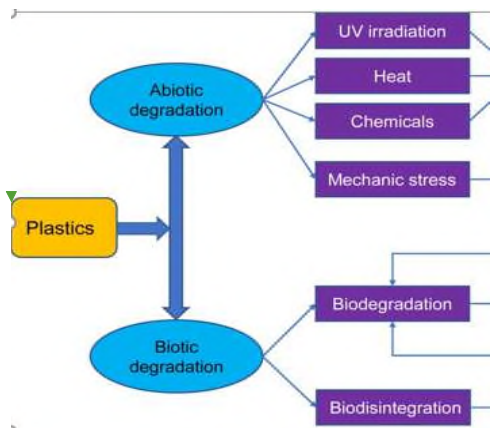
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## From plastic to micro-plastics

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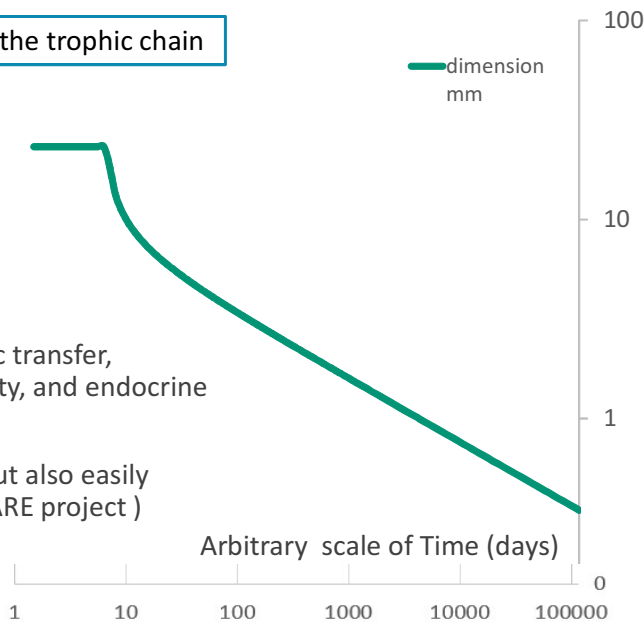
### Degradation Mechanisms



Plastic particles or fibres are subjected to several abiotic degradative reactions in aquatic ecosystems, including photodegradation, hydrolysis and mechanical degradation (Gewert et al., 2018; Zambrano et al, 2019, 2020).

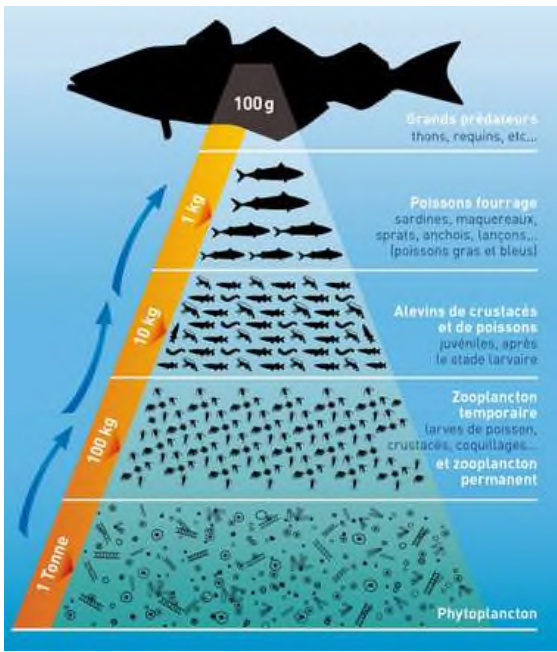
# From plastic to micro-plastics

## Ingestion across the trophic chain



Retention, trophic transfer, increased mortality, and endocrine disruption

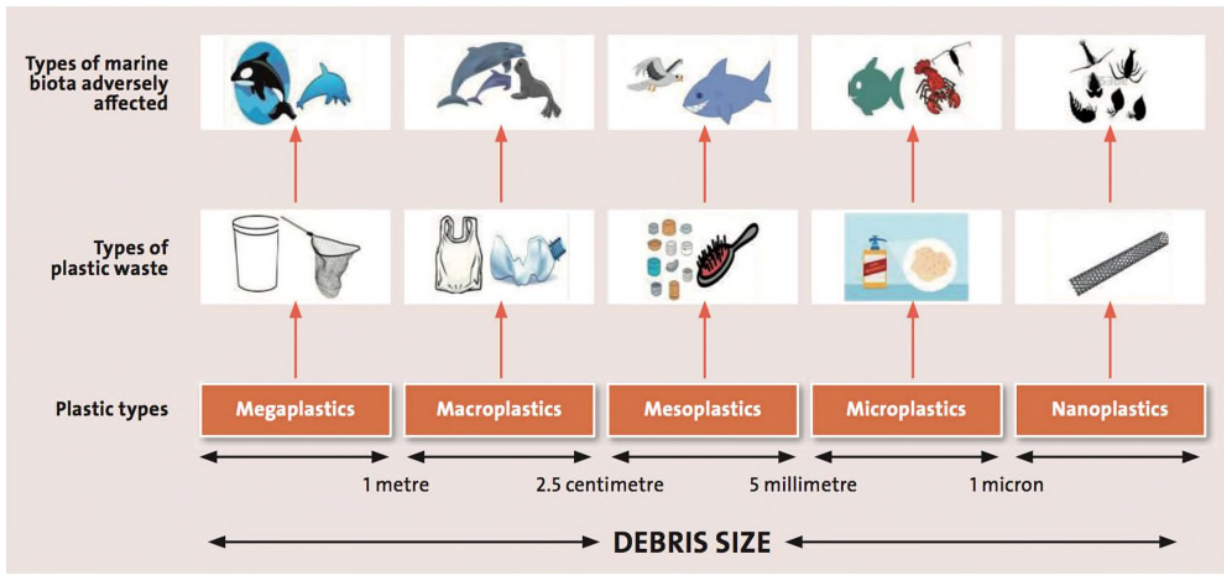
Easily ingested, but also easily egested (EPHEMARE project)



Based freely from Fanon Julienne, PhD, Université du Maine, 2019, France

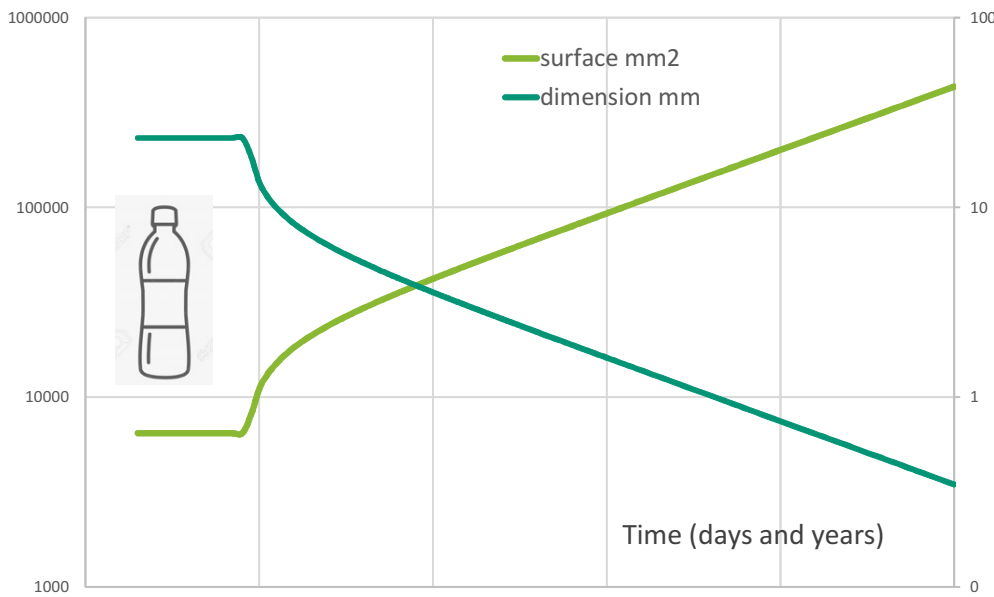
<http://www.plancton-du-monde.org/>

# From plastic to micro-plastics



<https://journals.openedition.org/factsreports/5257>

# From plastic to micro-plastics



**Fragmentation**  
 → Increase of the total surface area

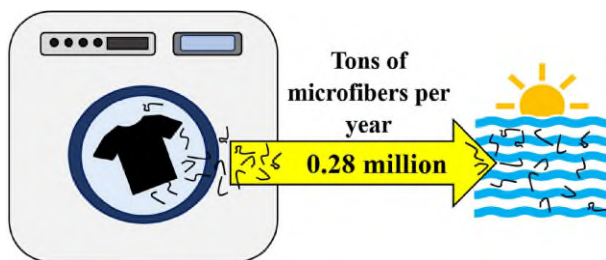
→ Leachage  
 Additives, such as plasticizers, stabilizers, flame retardants, dyes, pigments, antioxidants and antimicrobials, can leach from plastic material.  
 Potential risks to the environment

→ Long-distance vectors for invasive species and hydrophobic contaminants

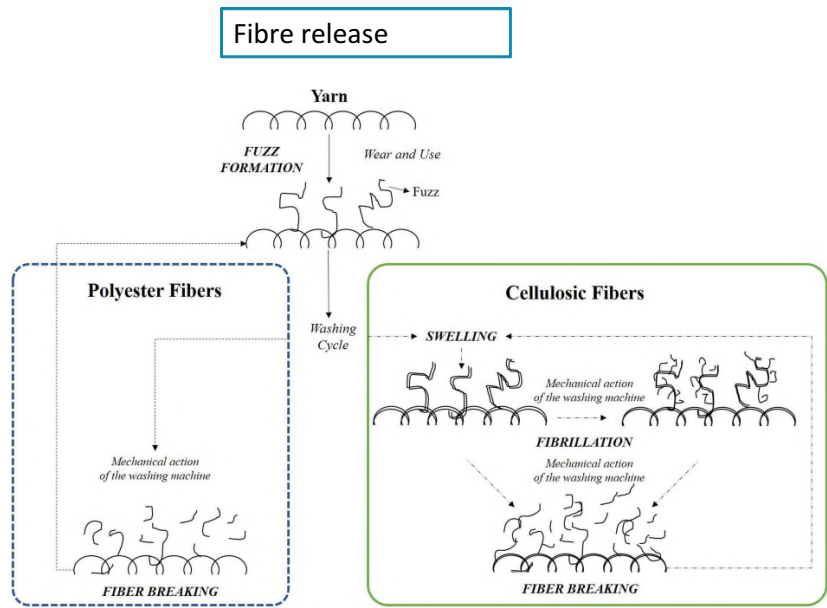
Adapted freely from Fanon Julienne, PhD, Université du Maine, 2019, France

Zhang 2021, Sait, 2021, Eebelein, 2021

# From garment to waste water



- Fiber release from fabrics**
- Fuzz formation
  - Fiber breaking
  - Cellulosics : Swelling and Fibrillation



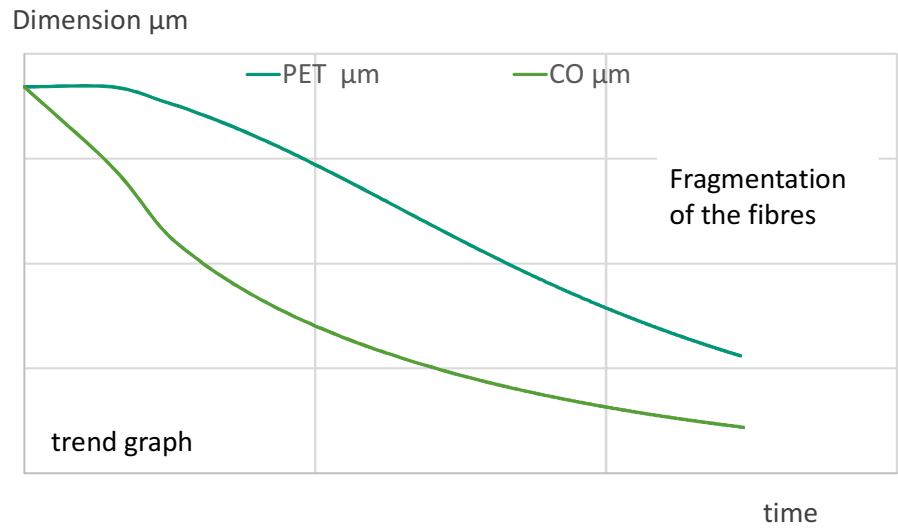
Polyester PET and CO cellulose-based fabrics all shed significant amounts of microplastics.

PET Microfibers similar to standard

More polyesters PET or more CO cellulose-based fibres?

Just after laundering : Initial amount CO > PET

In the environment : Degradation quicker with CO



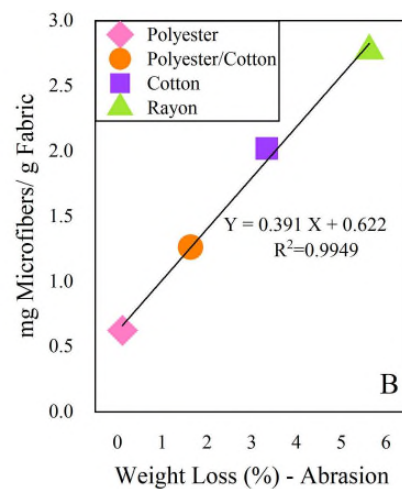
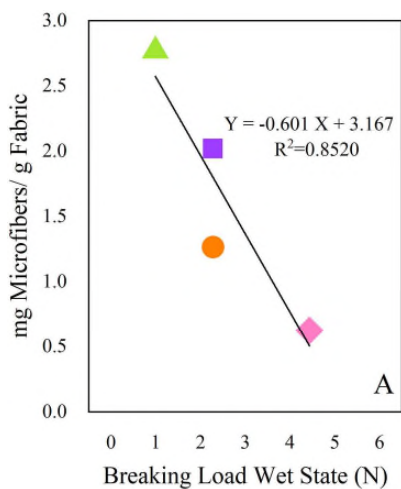
cotton and rayon are expected to degrade in natural aquatic environments whereas polyester microfibers are expected to persist in the environment for long periods of time

## Textile Structure

The fiber and yarn physicochemical properties play a major role in the microfiber generation.

Fabrics with higher abrasion resistance, low hairiness, and higher yarn breaking strength have a lower tendency to form fuzz and/or release microfibers during the mechanical action of washing.

Study with interlock fabrics



## Textile Treatments

Water repellent, durable-press finish and high abrasion resistant finishes  
 → reduce microplastics shedding  
 (Zambrano et al., 2021a) due to extra cross-linking,

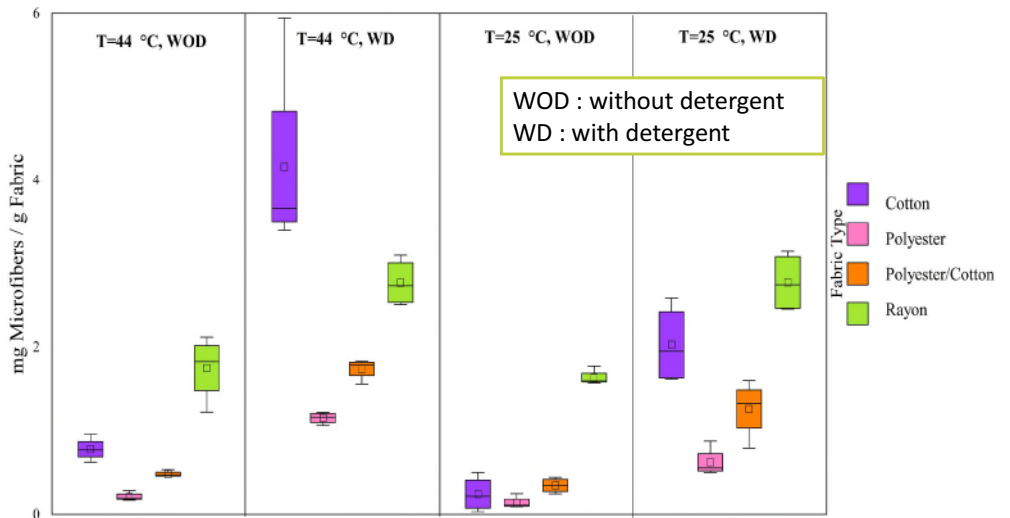
## Laundering

temperature, and use of detergent increases the generation of microplastics.

→ surfactant promotes fibers extraction from fabrics

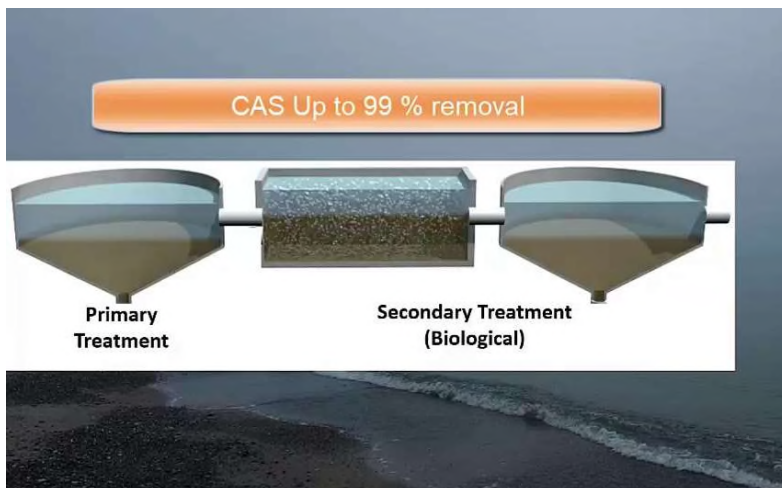
Softening :

More\* or less \*\* microplastics  
No clear effect



\* Marielis C. Zambrano , Joel J. Pawlak et al. In Environmental Pollution 272 (2021) 115998  
\*\*De Falco et al. / Environmental Pollution 236 (2018) 916e925

M. Zambrano, J. Pawlaka, J. Daystar, M. Ankeny, J. Cheng, R. Vendittia, Marine Pollution Bulletin 142 (2019) 394–407



Wastewater treatment plants contribute to the abatement of microplastics contamination from industrial and domestic sources.

→ Removal from the water stream (80 to 99%)

→ Challenge in the sludge stream : may subsequently end up in soil for agricultural use



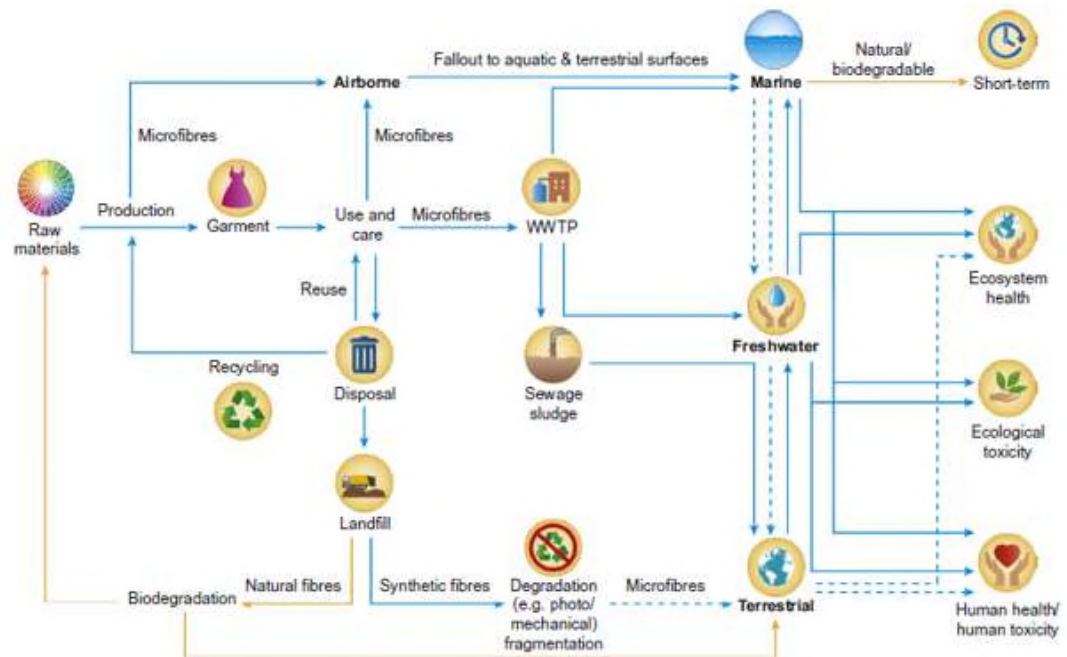
Sources:  
How to remove microplastics  
CEN/TC 248 "Textiles and textile products" 2021/05/06



Microplastics from fibers in Ocean, Fresh Water, Soil (Sludge), Air

<https://sciencepost.fr/influence-microplastiques-sur-climat-mondial/>

Fibres may be released without washing, during day-to-day wear of the clothes: and it has been stated that the quantities released in this way, by rubbing, brushing, etc, are equal to those produced during laundering (Palacios-Mateo et al., 2021)



Microfibres from apparel and home textiles: Prospects for including microplastics in environmental sustainability assessment Beverley Henry, Kirsi Laitala, Ingun Grimstad Klepp, Science of the Total Environment 652 (2019) 483–494

## conclusions

- Degradation and fragmentation of Fibers → microplastics
  - cellulosics degrades quicker, synthetics are persistent
- Influence of the environmental conditions → kinetics (years)
- Extraction of fibres from fabrics → Fuzz formation (friction) and fiber breaking (mechanical)
- Influence of Laundering conditions, fiber nature, textile structure, textile treatments
- Fiber release from fabric during the textile life cycle → in water, in sludge, in air

# Merci à tous!

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Ecy-Twin

Avec le soutien du Fonds Européen de Développement Régional

