The development of environmentally relevant microplastic reference materials

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Who am I, and what do I know about
Environmentally relevant microplastic reference materials

Oskar Hagelskjær

- Ph.D. in quantification of atmospheric MP pollution from university of Toulouse, France (2024).
- Founder of Microplastic Solution and EasyMP™ MP RMs.
- Experience with A to Z environmental MP analyses.

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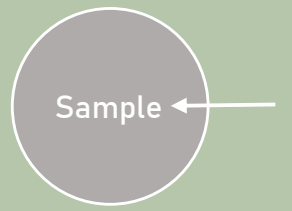
Environmental microplastics research

QA/QC in env. MPs research

Contamination

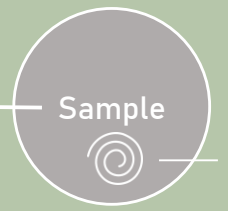


MP contamination in

QC: Estimate input of undesirable MPs

Loss/alteration

Indigenous MPs out



Indigenous MPs altered

QC: Estimate loss/alteration of indigenous MPs

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Why do we need

Environmentally relevant microplastic reference materials

Recovery experiments

Step 1 (digestion) *MP loss* → Step 2 (density separation) *MP loss* → Step 3 (membrane transfer) *MP loss*

Experimental studies demonstrate that microplastic loss from sample manipulation range from 15-42% (Way et al., 2022). However, In the case of very small microplastics <50 µm, procedural loss may even reach 50-90% (Hagelskjær et al., 2023b, 2023a; Weber and Kerpen, 2023).

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Why do we need

Environmentally relevant microplastic reference materials

Toxicology studies

From 73 in vivo lab studies, and 41 soil studies, we found that lab studies have fed rodents microplastics at concentrations that were hundreds of thousands of times greater than they would be exposed to in nature. Health effects have been studied for only 20% of the microplastic polymers that are known to occur in soils. (Mills et al., 2023).

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What is the current standard for ~~Environmentally relevant~~ microplastic reference materials

Beads/spheres

The current standard in MP recovery experiments due to:

- Easy to use and identify
- Readily available
- Not environmentally relevant

  ⟶ geometry with lowest possible surface-area-to-mass ratio.
  Important: low degree of chemical leaching and physical adhesion
  No roughness!

  ⟶ Monodisperse or narrow size range.

  ⟶ Limited selection of polymers

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How do we define
Environmentally relevant microplastic reference materials

What do we know about environmental MPs?

- Most environmental MPs stem from the fragmentation of legacy plastic items, primarily caused by a combination of photodegradation and physical abrasion.

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How do we define
Environmentally relevant microplastic reference materials

What do we know about environmental MPs?

- Most environmental MPs stem from the fragmentation of legacy plastic items, primarily caused by a combination of photodegradation and physical abrasion.

- MPs create MPs; For this reason, the majority of environmental MPs posses a fragment-type morphology, especially as particle size decreases.

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How do we define
Environmentally relevant microplastic reference materials

What do we know about environmental MPs?

- Most environmental MPs stem from the fragmentation of legacy plastic items, primarily caused by a combination of photodegradation and physical abrasion.

- MPs create MPs; For this reason, the majority of environmental MPs posses a fragment-type morphology, especially as particle size decreases.

- However, the distribution and nature of MPs in an environmental sample depend heavily on the investigated environment as well as the applied methodology of investigation.

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How do we define

Environmentally relevant microplastic reference materials

...It depends

Case #2
Beads/spheres
[cosmetic product + FT-IR]

Case #3
Fibers
[indoors + visual inspection]

Case #1
Fragments
[remote location + µRaman]

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Common denominators for
Environmentally relevant microplastic reference materials

Keyword: Top-down

Cryogenic milling: Replicate shape of environmental MPs

↓

Sieving and sorting: Polydisperse in relevant size groups

↓

Quantification: Accurate *i.e.* <20% relative standard deviation

↓

Dosing: Easy dosing in environmentally relevant concentrations

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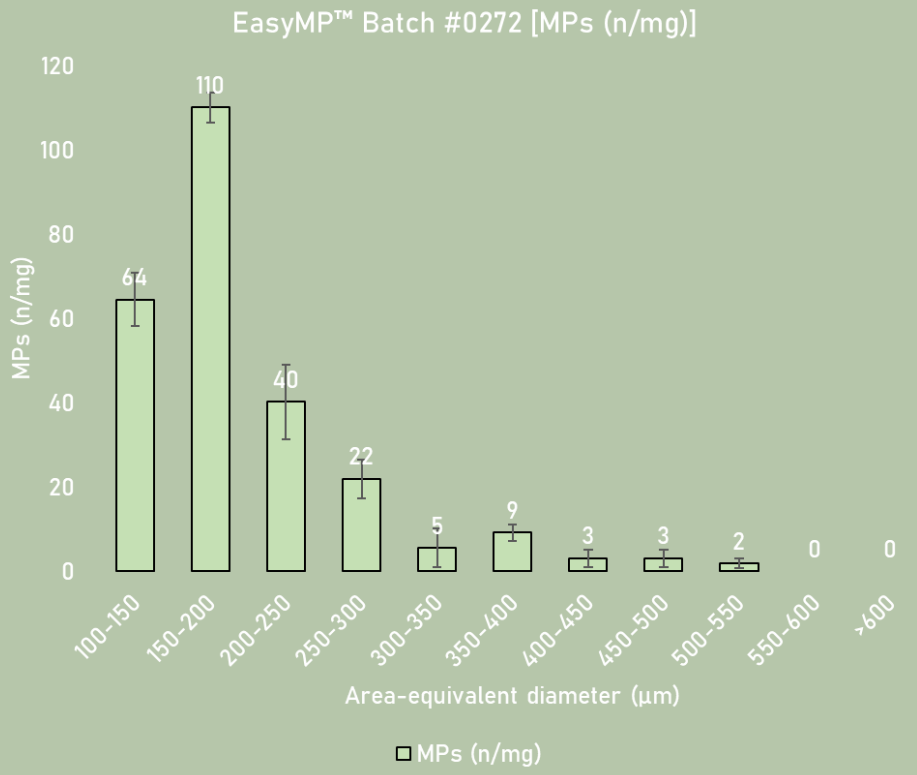
How we quantify

Environmentally relevant microplastic reference materials

4 x

=



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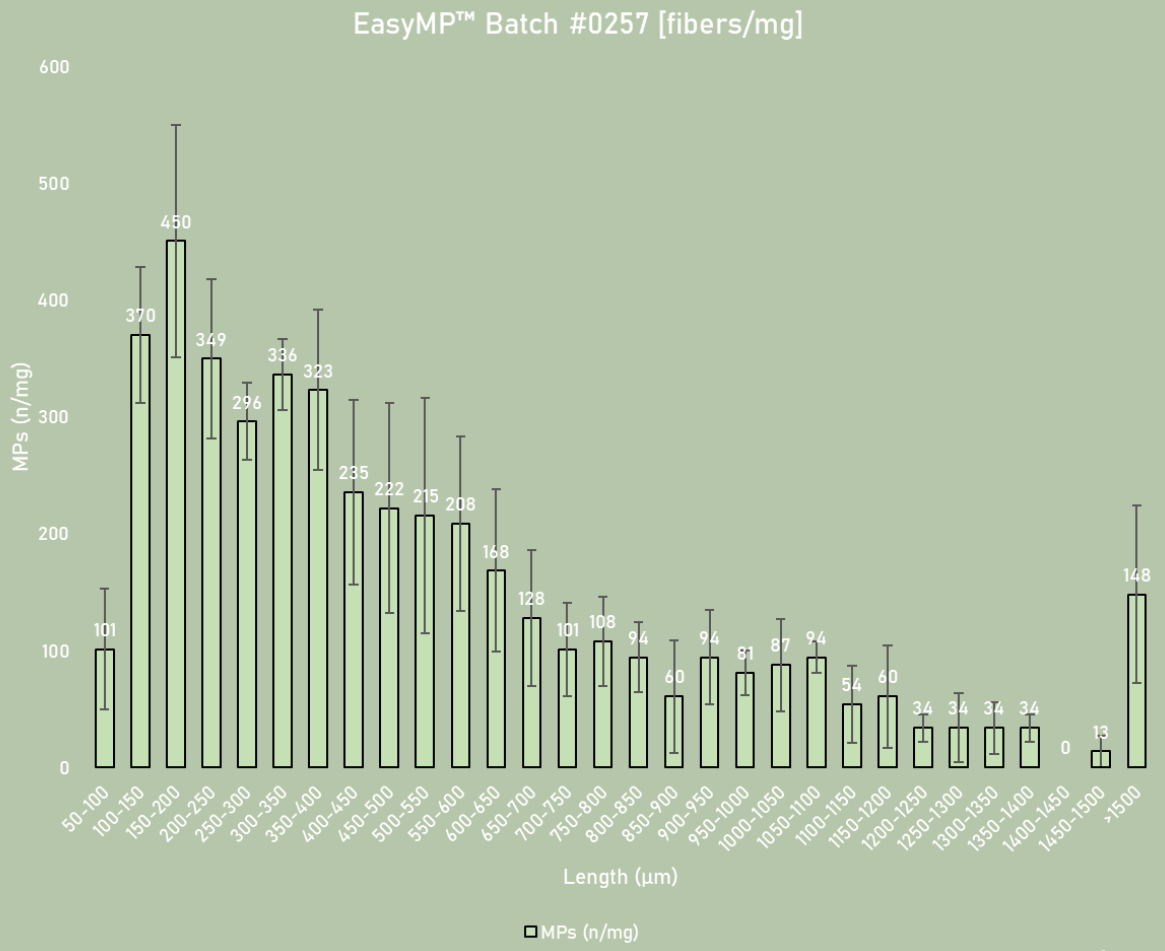
How we quantify

Environmentally relevant microplastic reference materials

4 x

=



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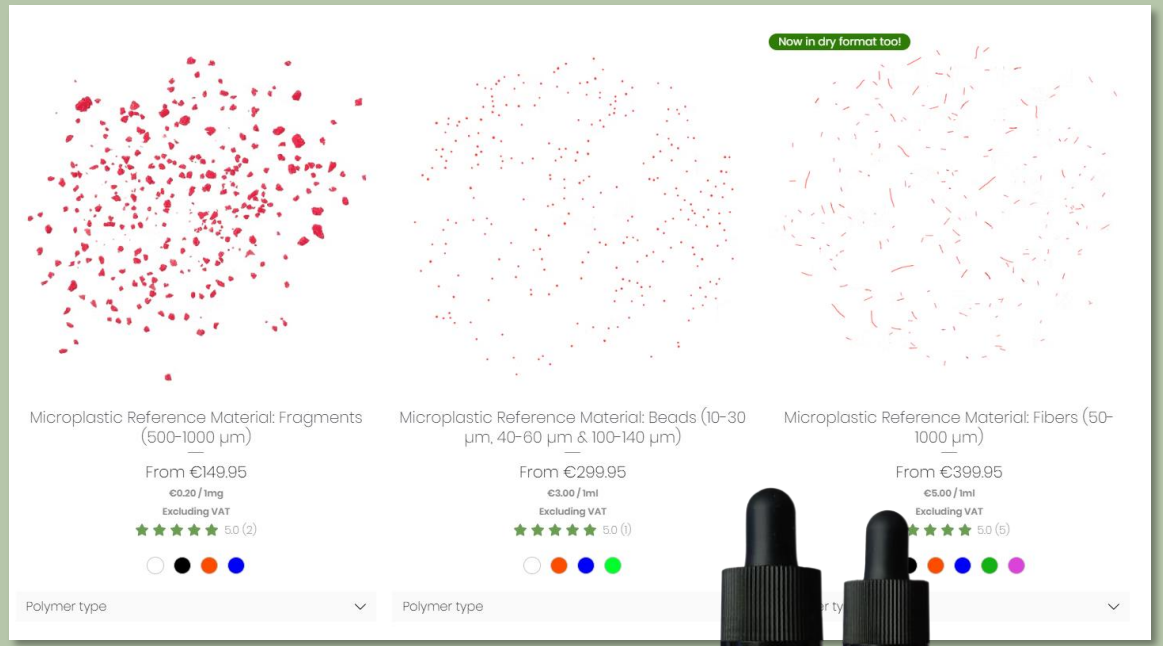
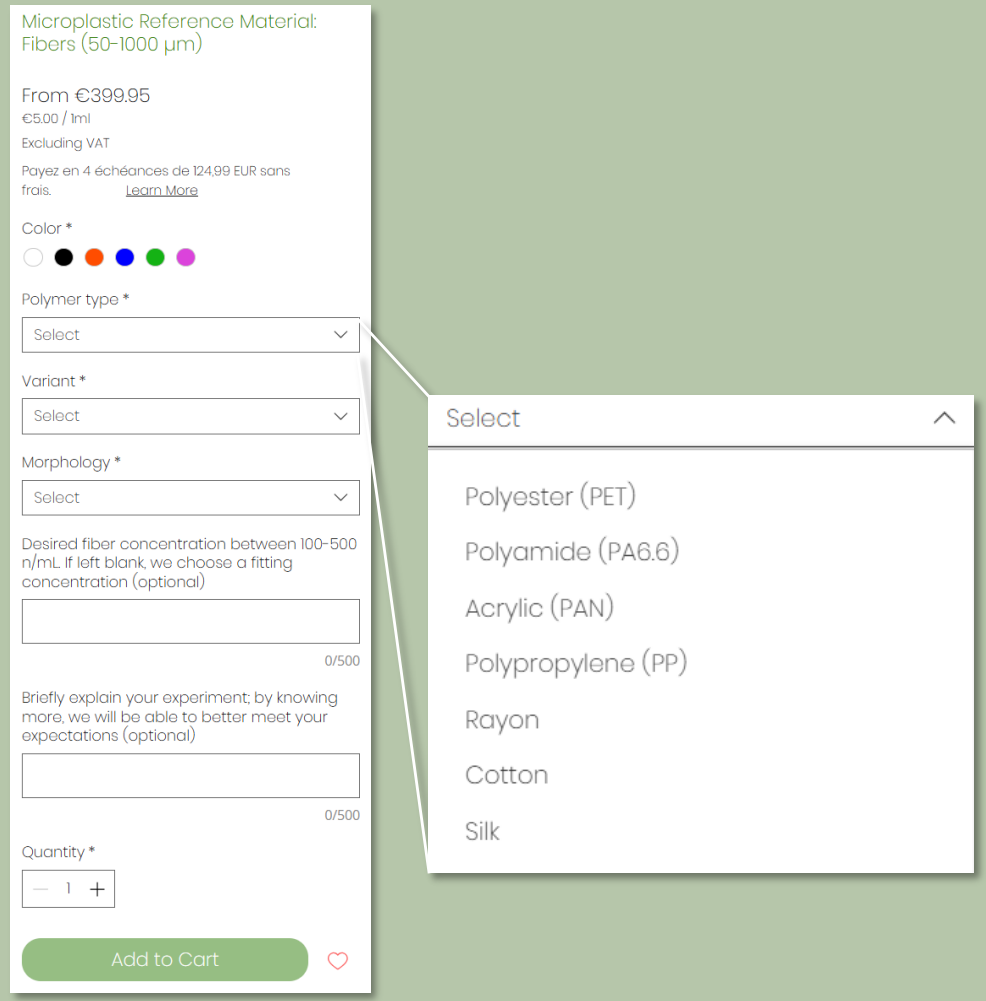
How we democratize

Environmentally relevant microplastic reference materials





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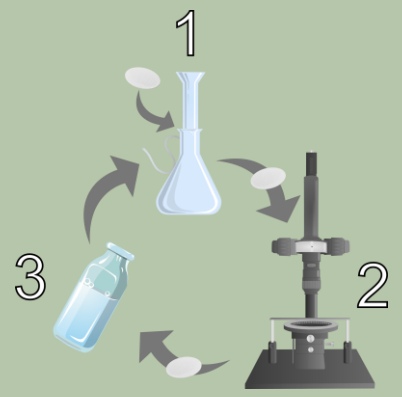
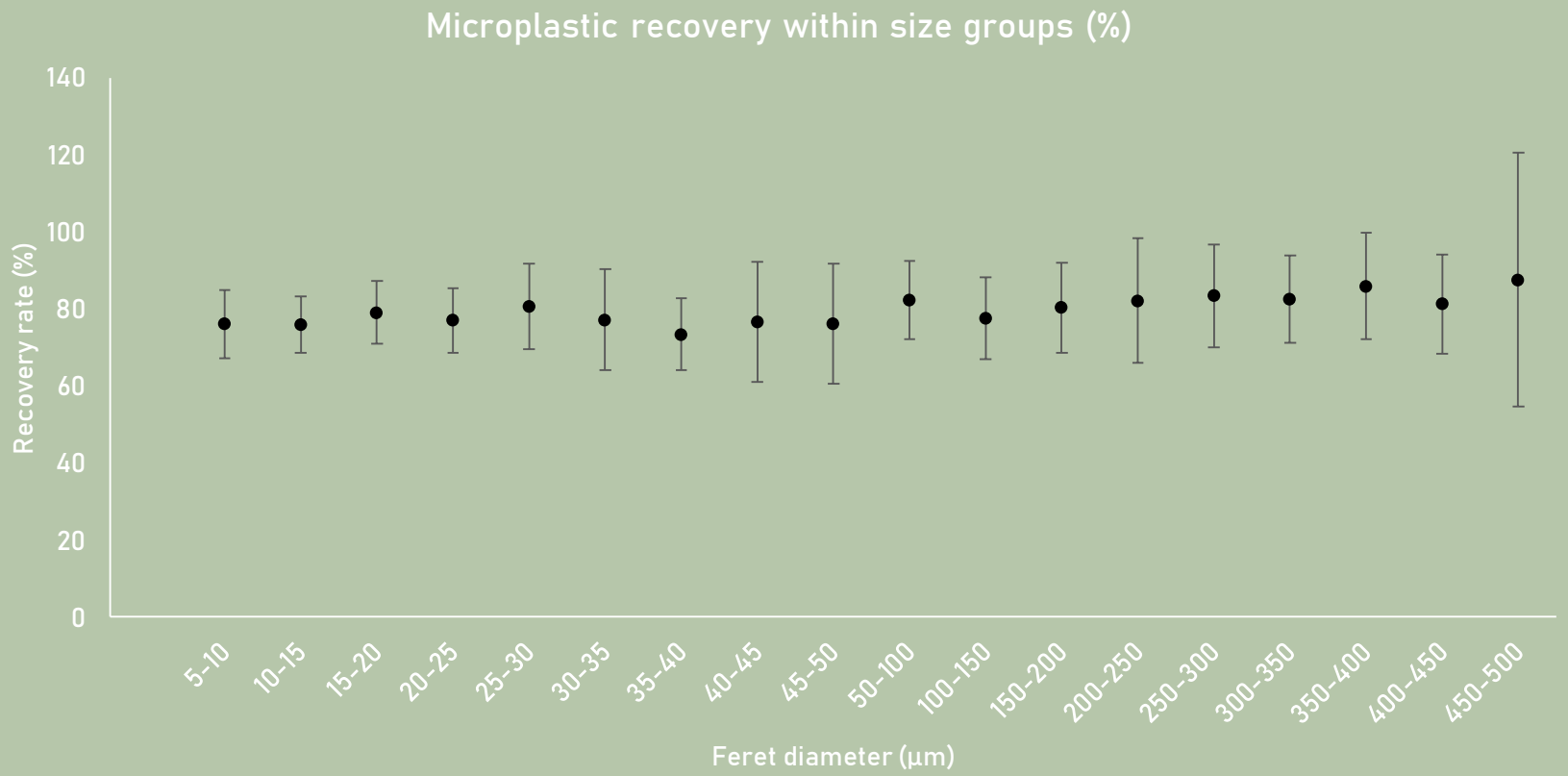
What we have learned from using
Environmentally relevant microplastic reference materials

Is there a link between microplastic recovery and particle size?



Simple protocol

transfer from filter to container,
glassware flushed with water



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What we have learned from using
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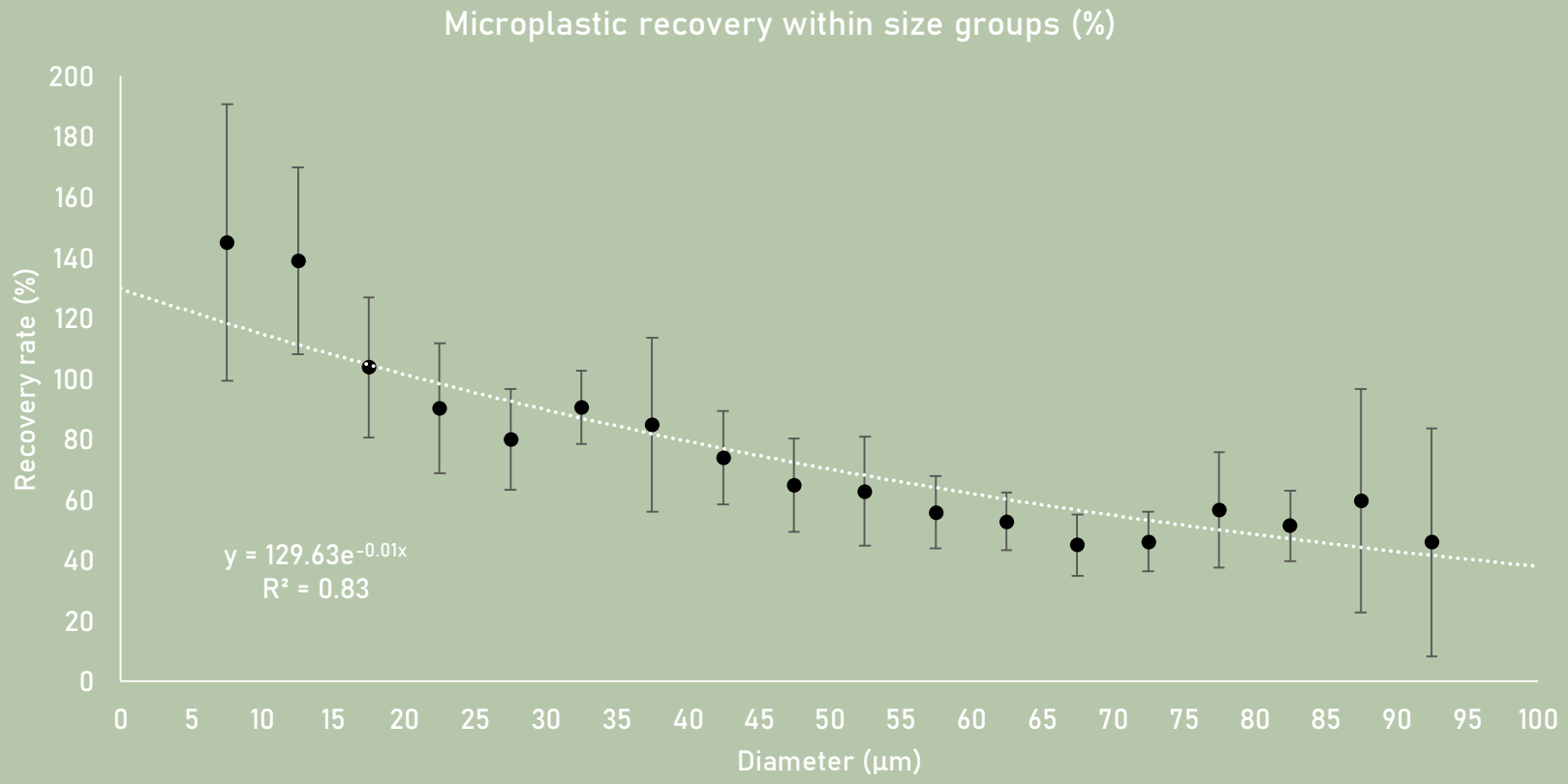
Is there a link between microplastic recovery and particle size?

Multi-step protocol
Oxidative & acid digestion
+
Ultrasonication



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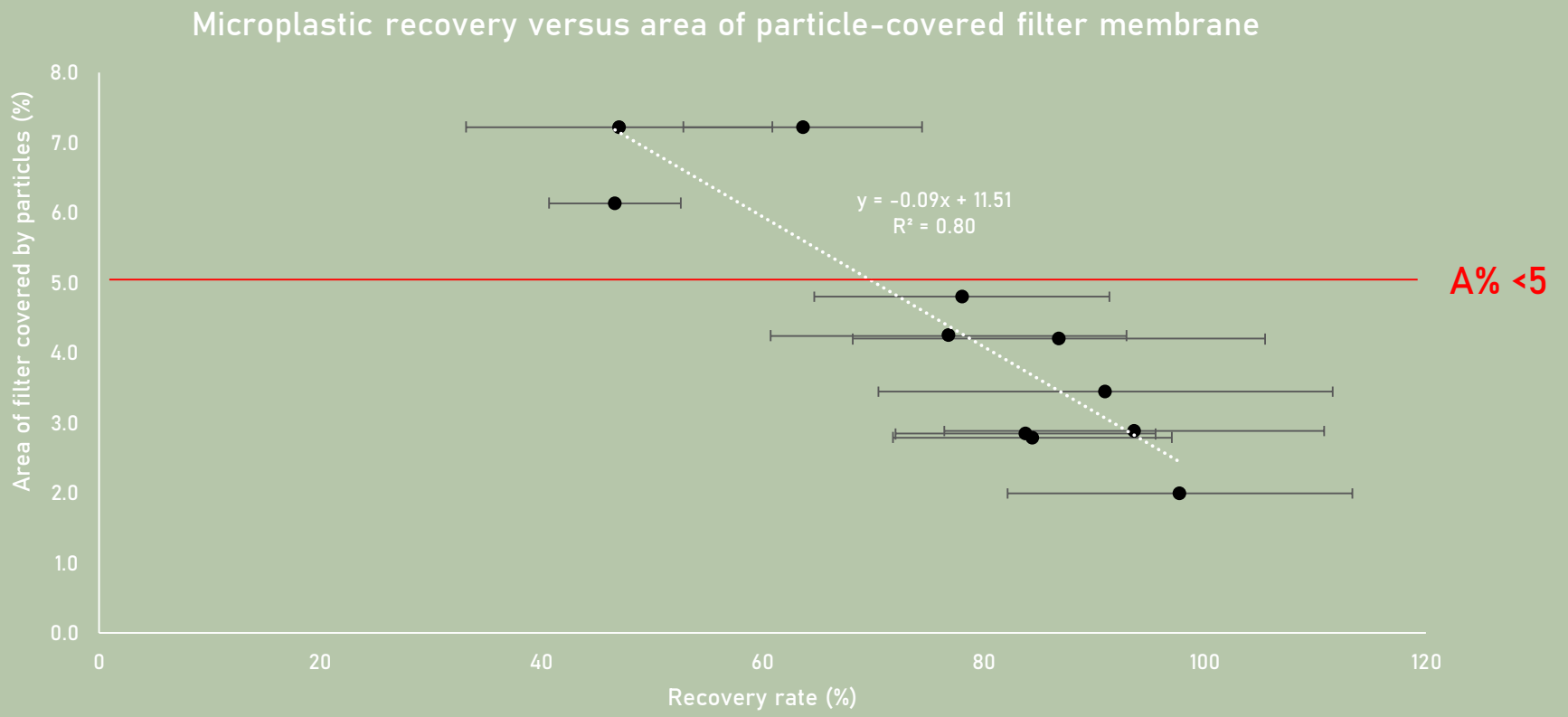
Is there a correlation between microplastic recovery and particle size?



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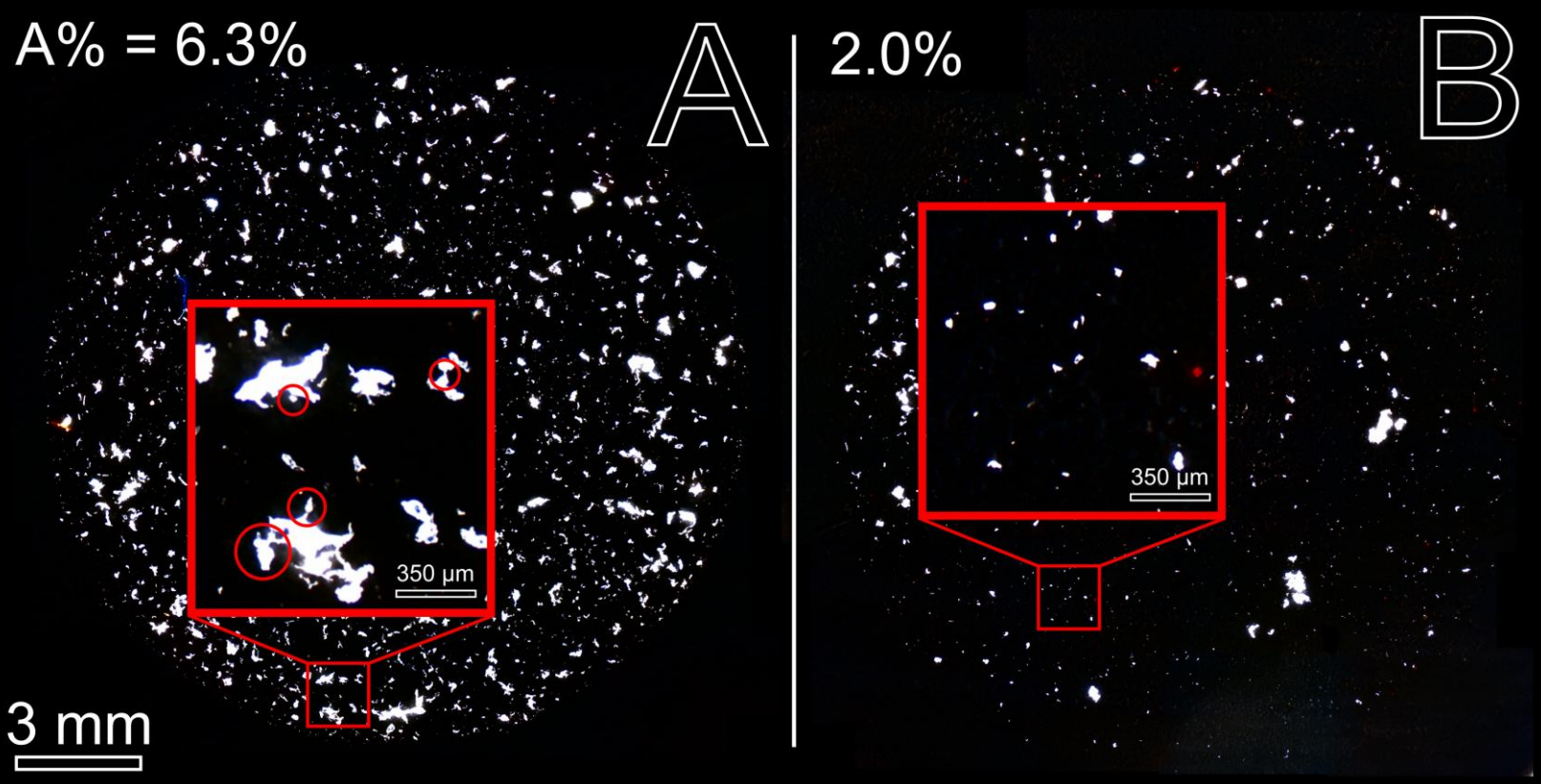

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What we have learned from using
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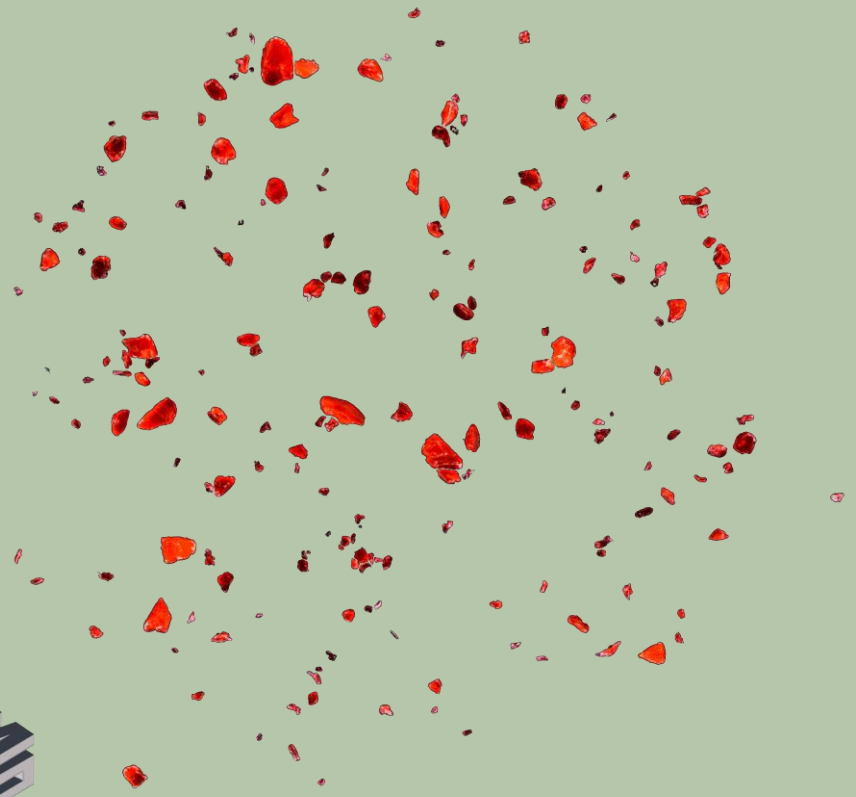
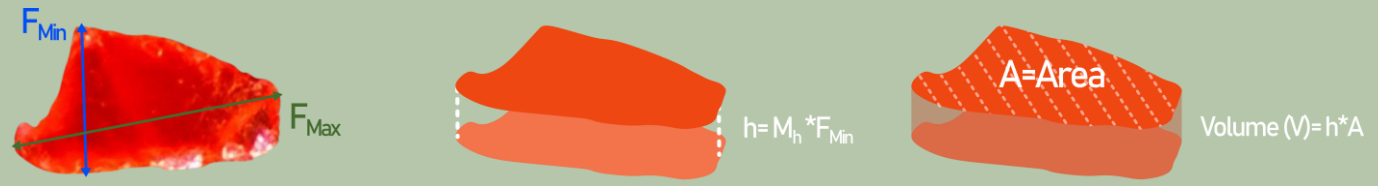
Calibrating a 2D-morphology-to-mass equation





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What we have learned from using
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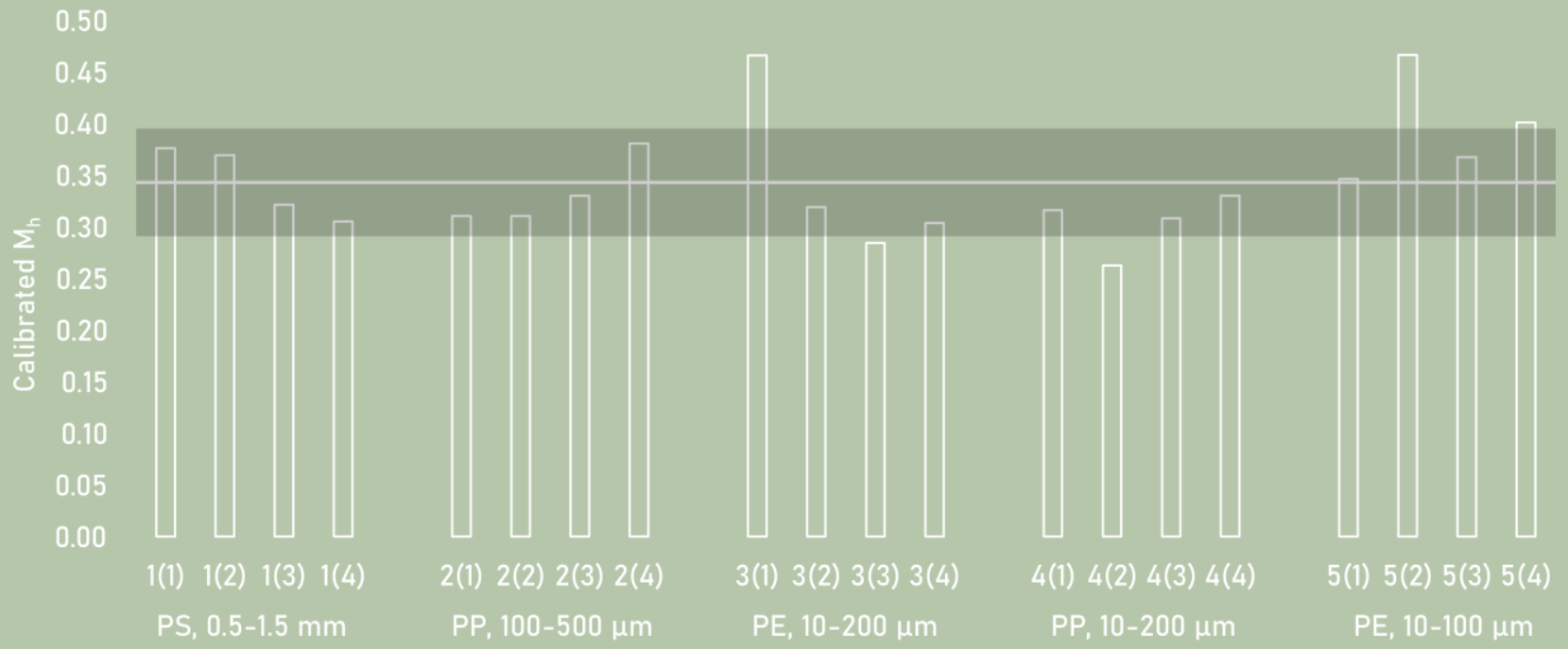
Calibrating a 2D-morphology-to-mass equation

$$m = \rho \cdot \left((0.34 \cdot \mathrm{F_{Min}}) \cdot \mathrm{A}\right) \rightarrow$$



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What are the next steps for

Environmentally relevant microplastic reference materials

EasyMP™ → ExactMP™

EasyMP™

Based on 4 subsamples.
< 20% RSD.

ExactMP™

Equals one subsample.
Exact content = no error.

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What are the next steps for
Environmentally relevant microplastic reference materials

Access to- and deeper understanding of morphology and chemistry

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What are the next steps for
Environmentally relevant microplastic reference materials

Unravelling the more than 16,000 plastic-associated chemicals protected by trade secrets

"plastic additives are not simply optional extras; they are essential ingredients which can make all the difference between success and failure in plastics technology" (Pritchard, 2012).

"We need transparency and harmonization through collaboration"

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Take-home messages for the development of Environmentally relevant microplastic reference materials

- Adapted MP reference materials for the relevant analytical method and environmental sample matrix.
- More focus on simulated environmental degradation in production of environmentally relevant MPs.
- Need for transparency in the plastic additive market.

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