

# Environmental and human exposure to micro- and nanoplastics: implications for health and decision-making

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# Prof. Dr. Dick Vethaak Award 2025

- The Dick Vethaak Award in honour of Dick Vethaak is organised by **Plastic Soup Foundation**.
- Thank you to the board and jury:
- Dr. Concepción Martínez-Gómez (Instituto Español de Oceanografía, CSIC)
- Prof. Dr. Juliette Legler (Utrecht University)
- Prof. Dr. Marja Lamoree (Vrije University Amsterdam)
- Prof. Dr. Lukas Kenner (University of Vienna),
- Dr. Heather Leslie (Heather Leslie Projects Amsterdam)
- Maria Westerbos (Founder Plastic Soup Foundation)



## Plastic Debris Is a Human Health Issue

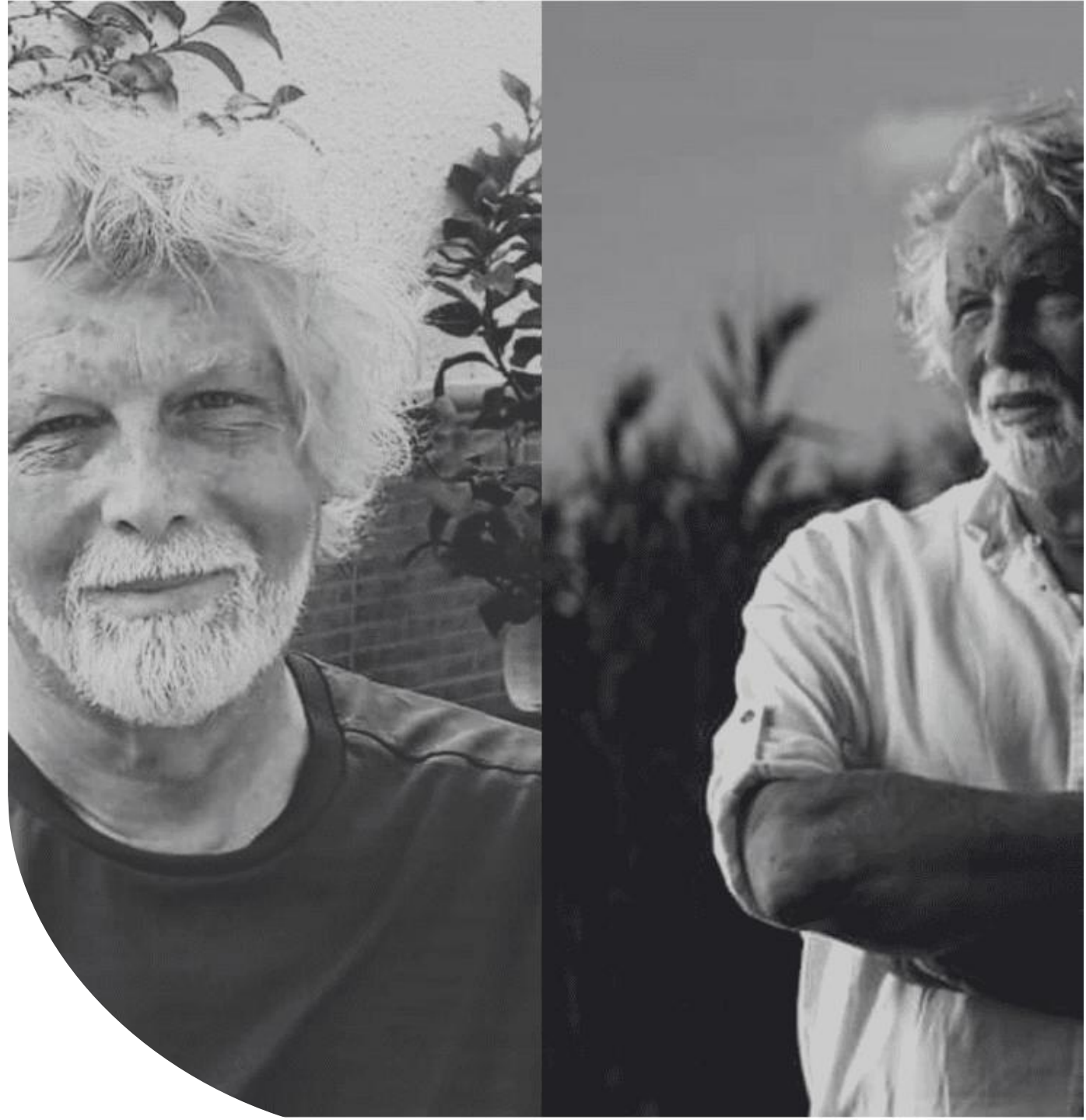
A. Dick Vethaak<sup>\*,†,‡</sup> and Heather A. Leslie<sup>‡</sup>

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<sup>‡</sup>VU University Amsterdam, Institute for Environmental Studies (IVM), De Boelelaan 1087, 1081 HV Amsterdam,

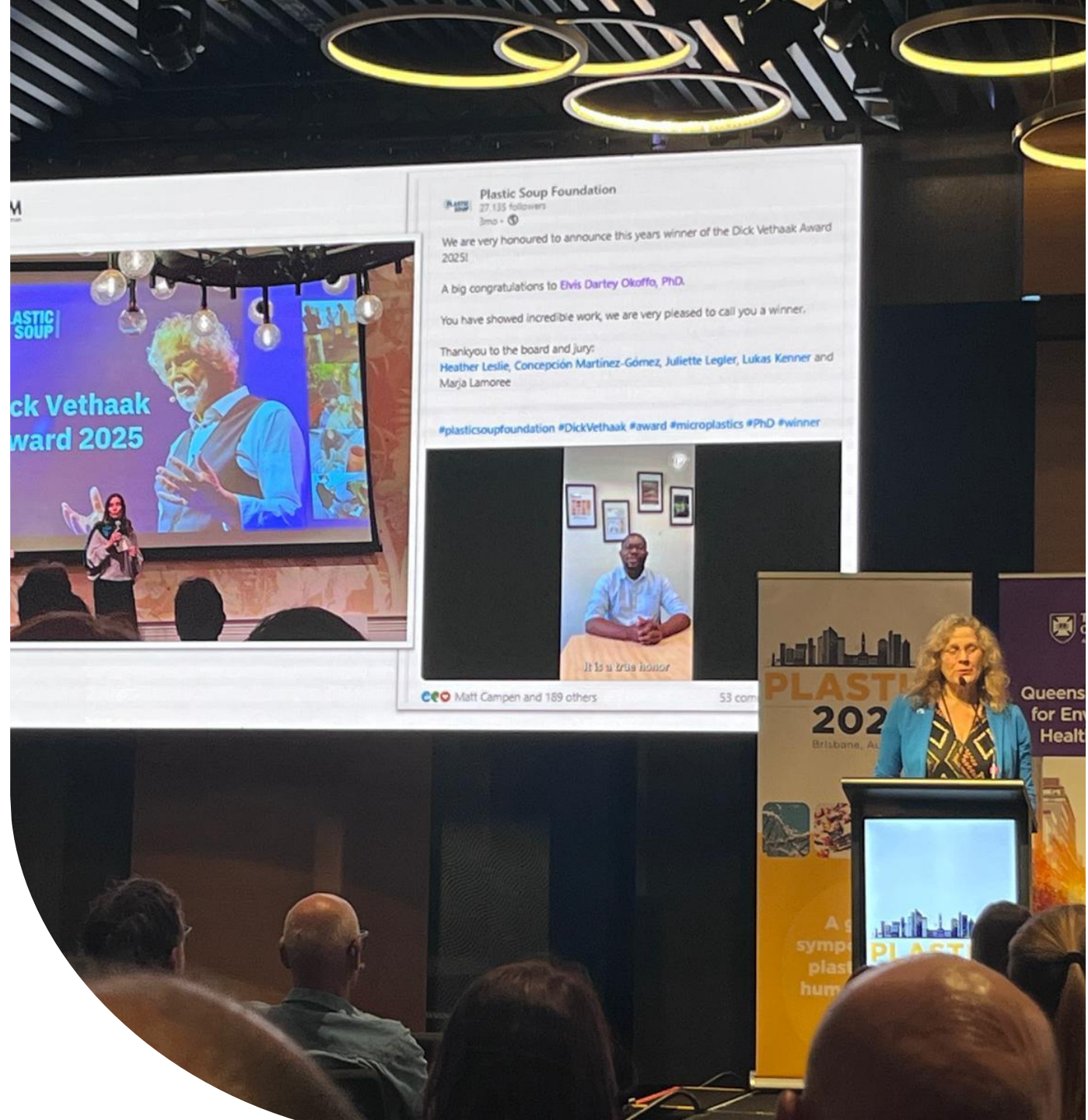


2. CHEMICAL TOXICITY

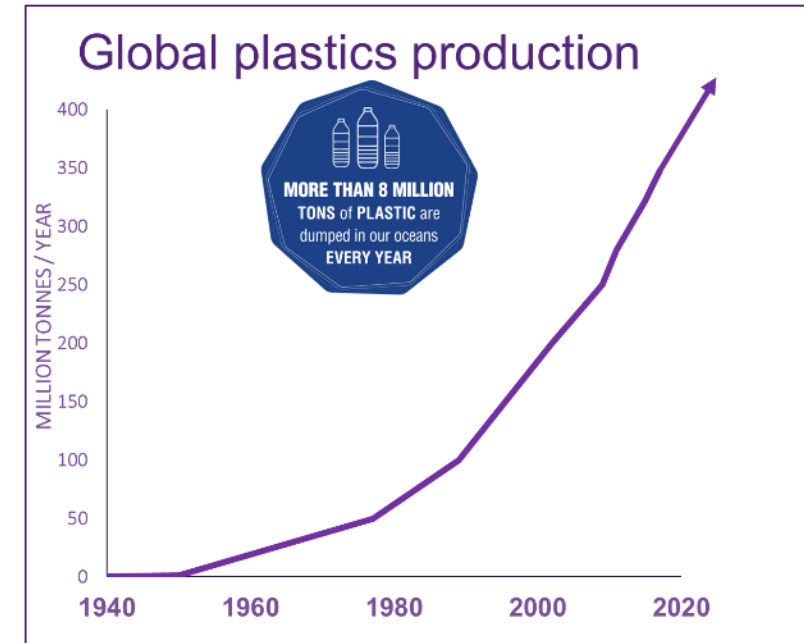


# MOMENTUM invitation

- Prof. Dr. Juliette Legler (Utrecht University)
- Fela, Esmeralda, Emma



# Why do we care about plastics?



## Plastic fibres found in tap water around the world, study reveals

Exclusive: Tests show billions of people globally are drinking water contaminated by plastic particles, with 83% of samples found to be polluted

● We are living on a plastic planet. What does it mean for our health?



▲ The average number of fibres found in each 500ml sample ranged from 4.3 in the US to 1.3 in Europe.

# Microplastic and Nanoplastics (MNP) <5mm

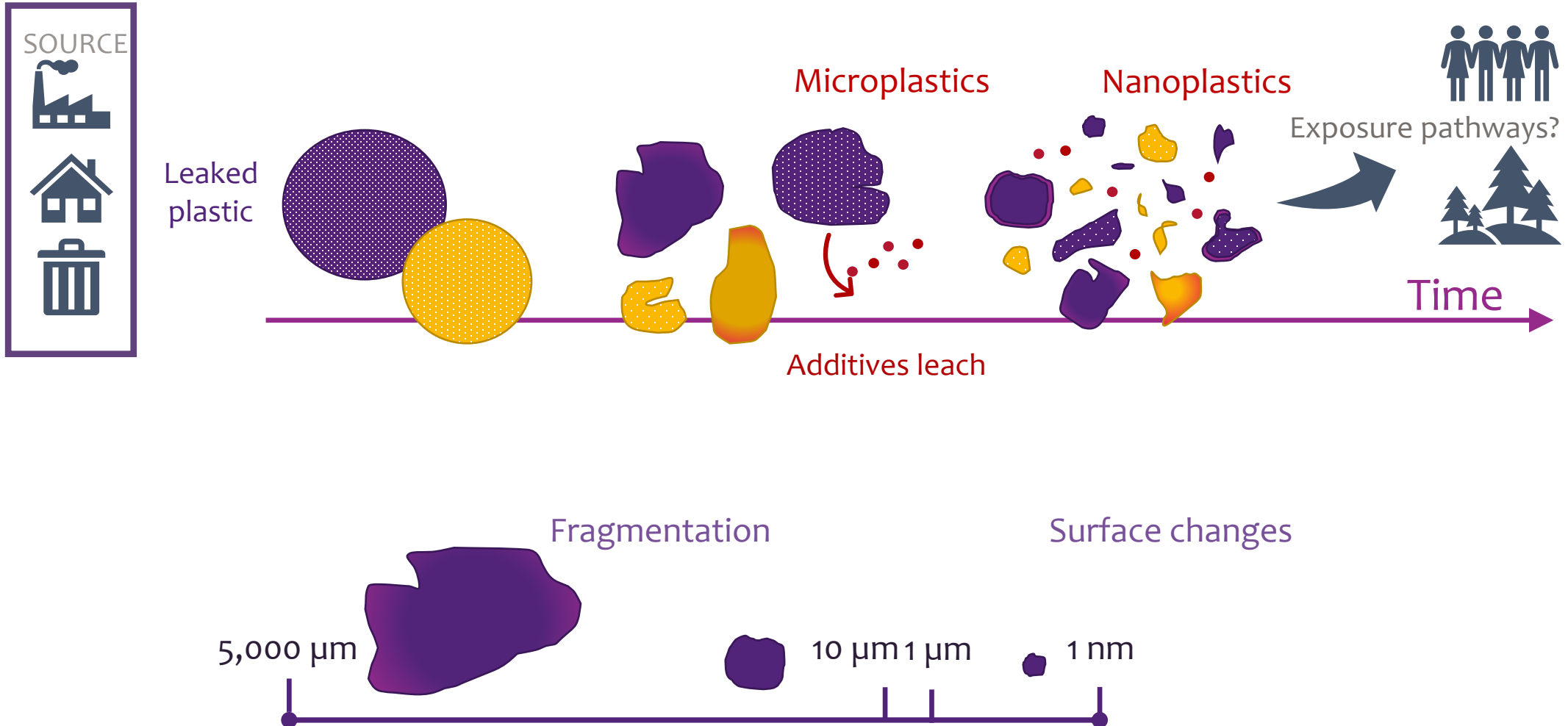
Primary MNP



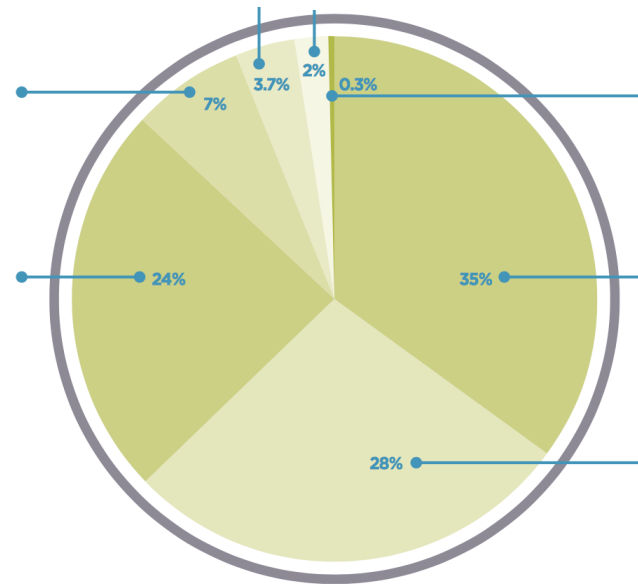
Secondary MNP



# Breaking down over time to smaller plastics



# Global releases of primary microplastics to the world oceans



# Pyrolysis-Gas Chromatography Mass Spectrometry

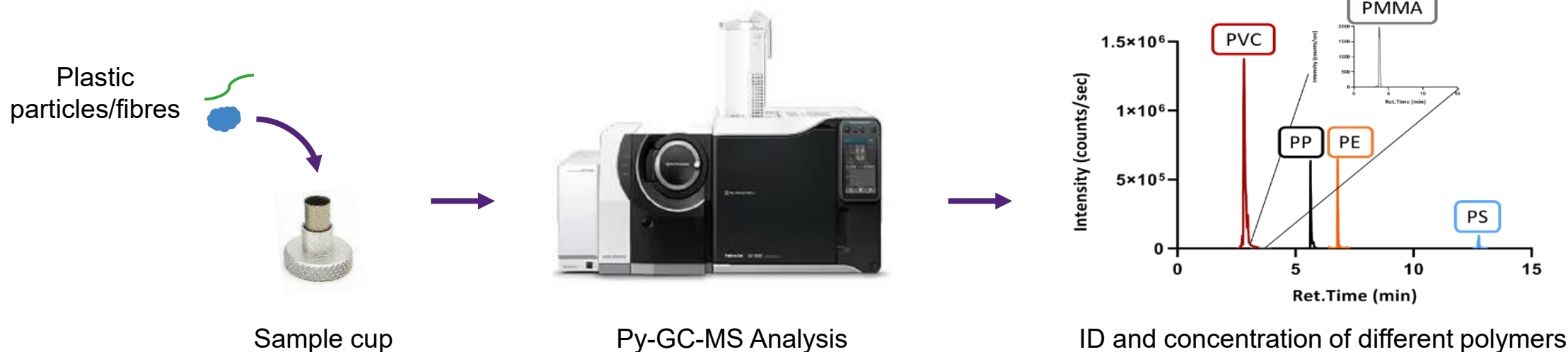
- *Mass based quantification*

Plastic is thermally decomposed at 650°C – breaks down into smaller molecules

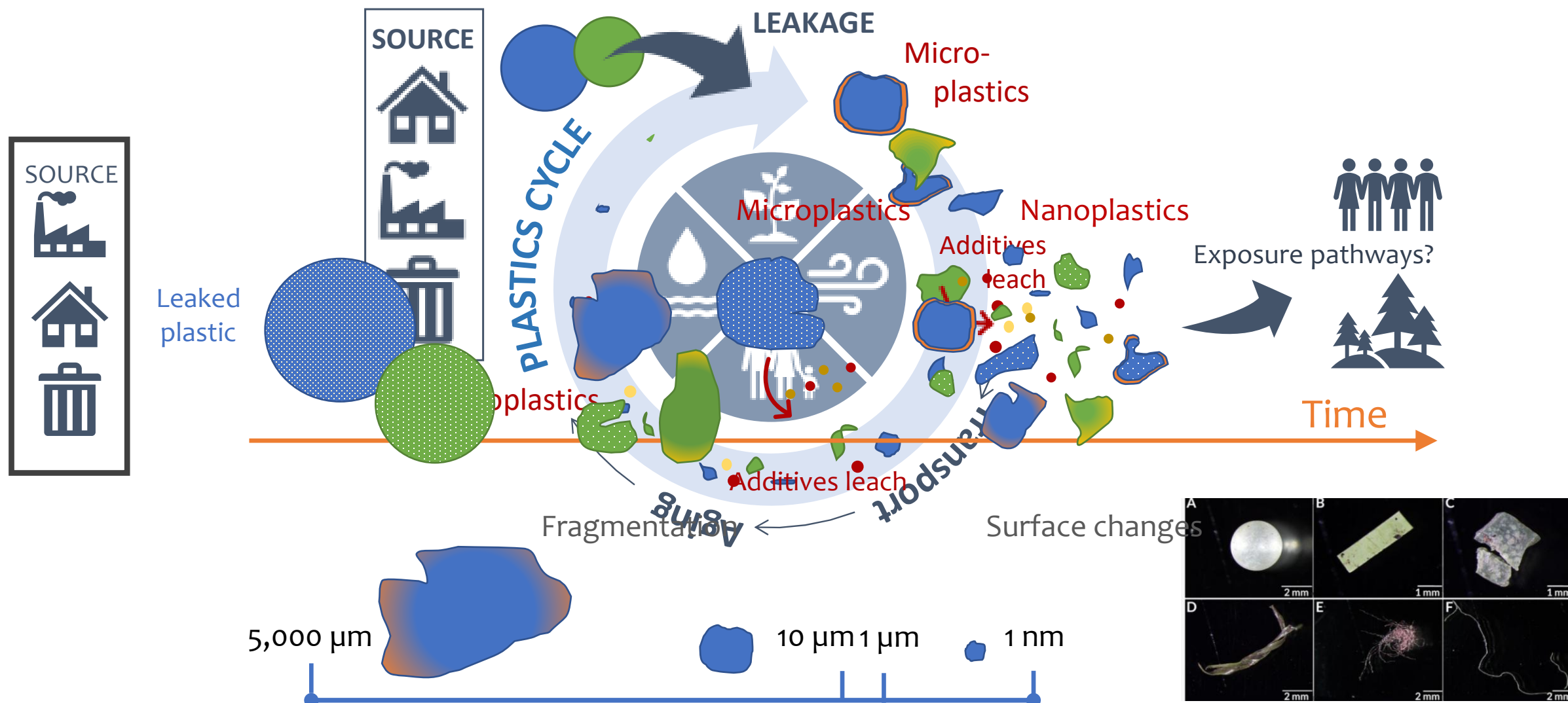
Small molecules are separated and detected with GC-MS

Results reported as total mass of each plastic in a sample

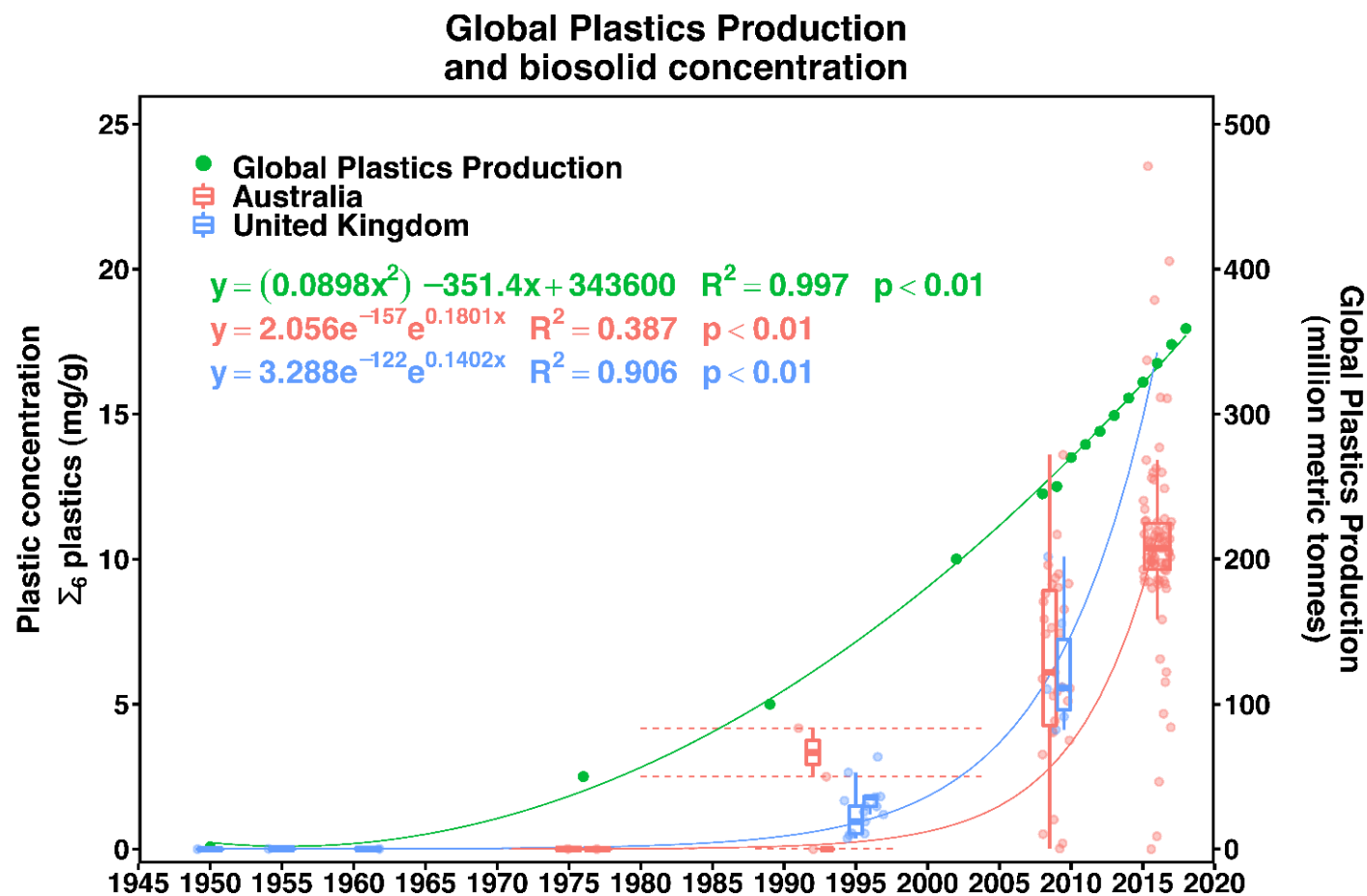
Is not size limited but does not provide characterisation (morphological) details



# Environmental plastics cycle

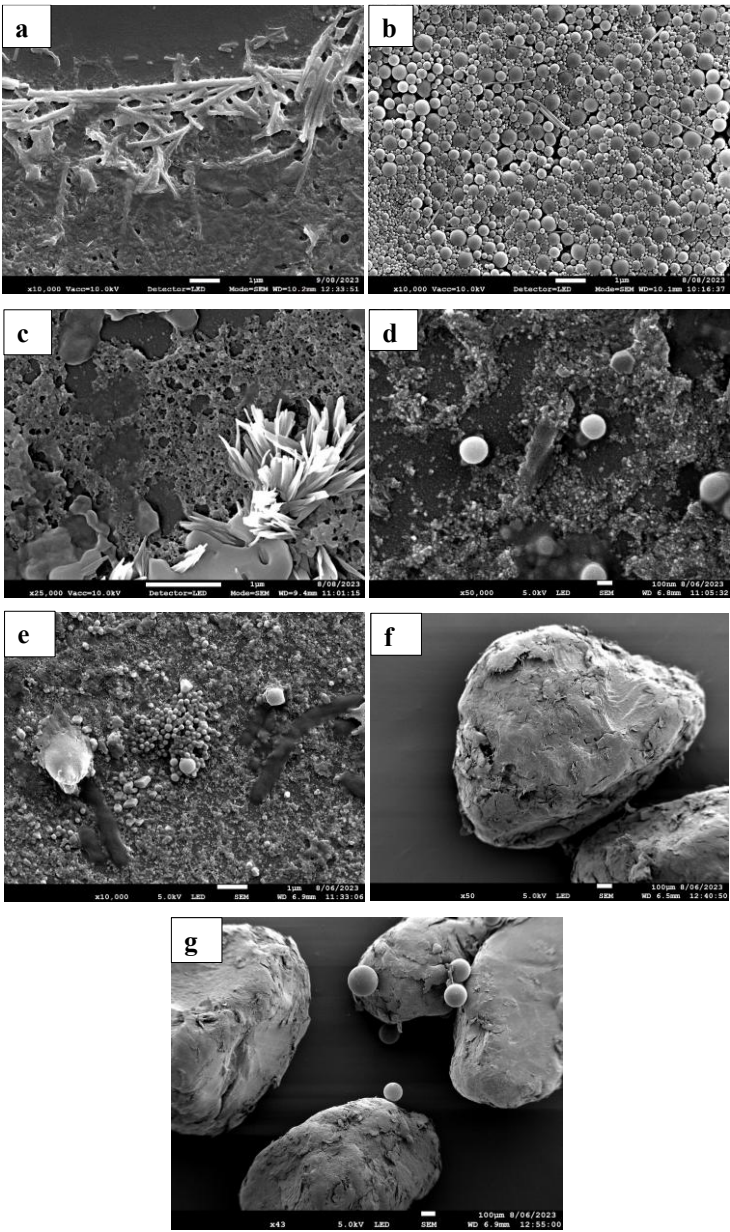
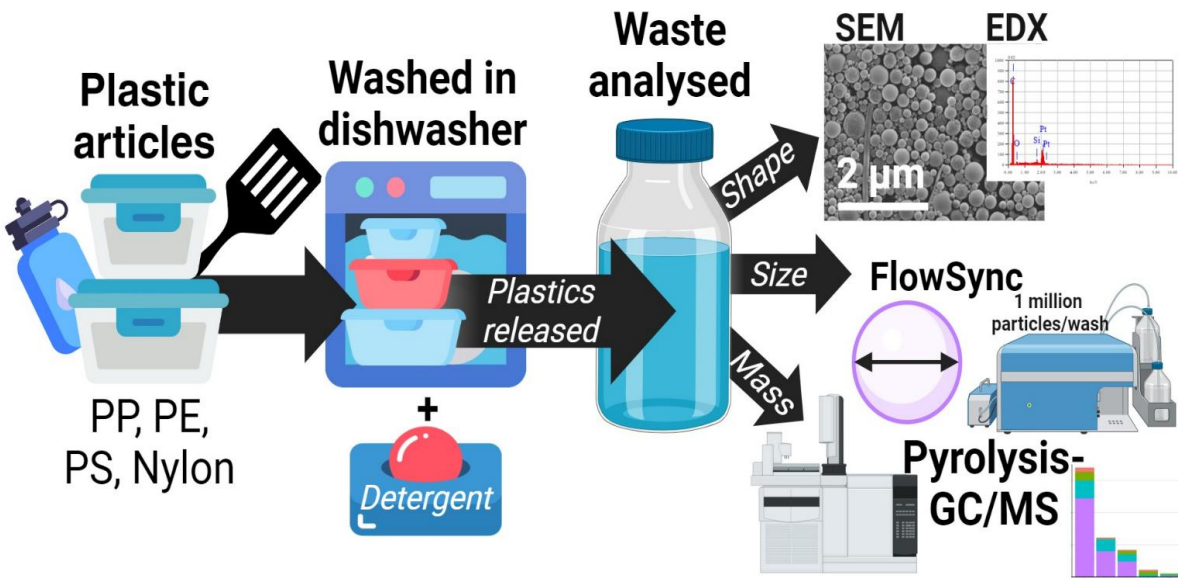


# Looking back in time: Plastics in biosolids from 1950 to 2016



- Dishwashers

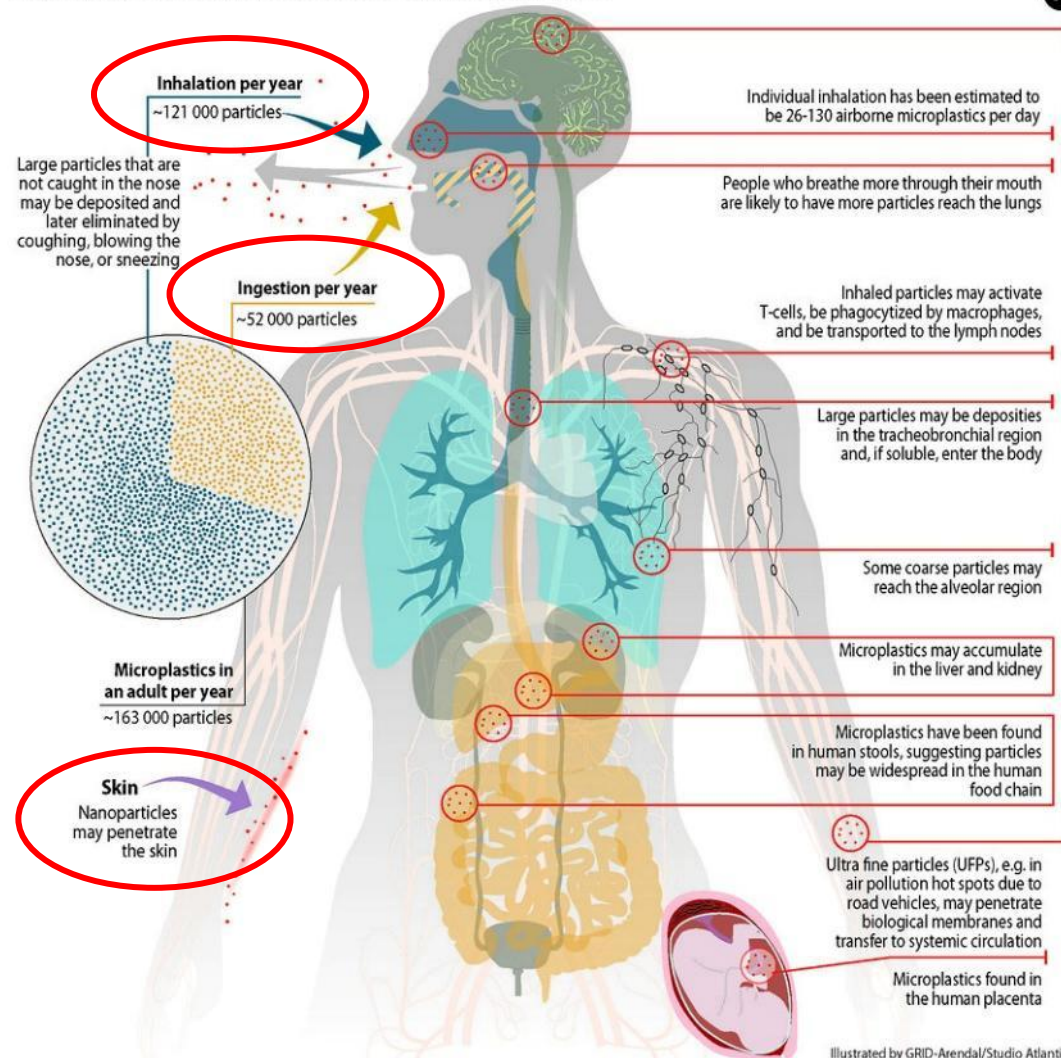
Plastics in dishwasher waste



- 920,000 particles/cycle
- 170 million particles/household/year
- Not a major source

# Human Exposure Pathways

Human exposure to microplastic and nanoplastic particles



United Nations Environment Programme (2021). From Pollution to Solution: A global assessment of marine litter and plastic pollution. Nairobi.

**There is clear evidence that we are ingesting and inhaling microplastics**

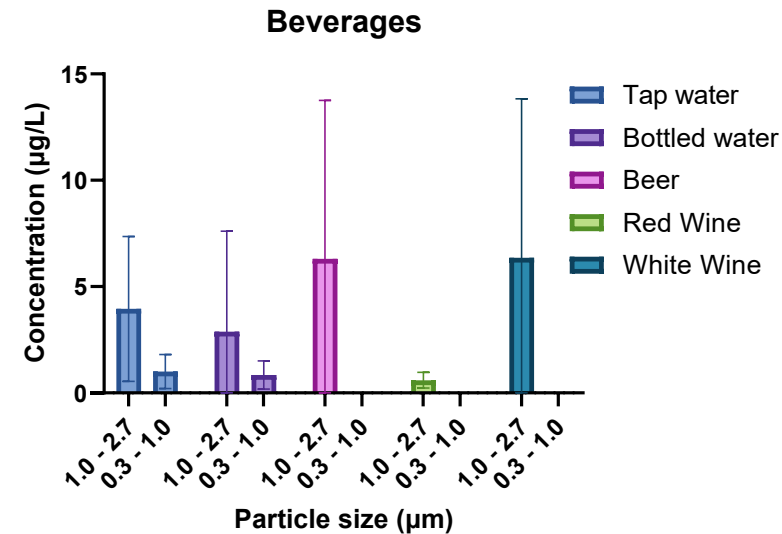
- What are the sources of this exposure?
- What particle sizes are we exposed to?
  - Implications for internalisation
- Knowing **what** we are exposed to can direct biomonitoring studies and toxicity assessments



# What are we ingesting?

## Higher detections in beverages than food

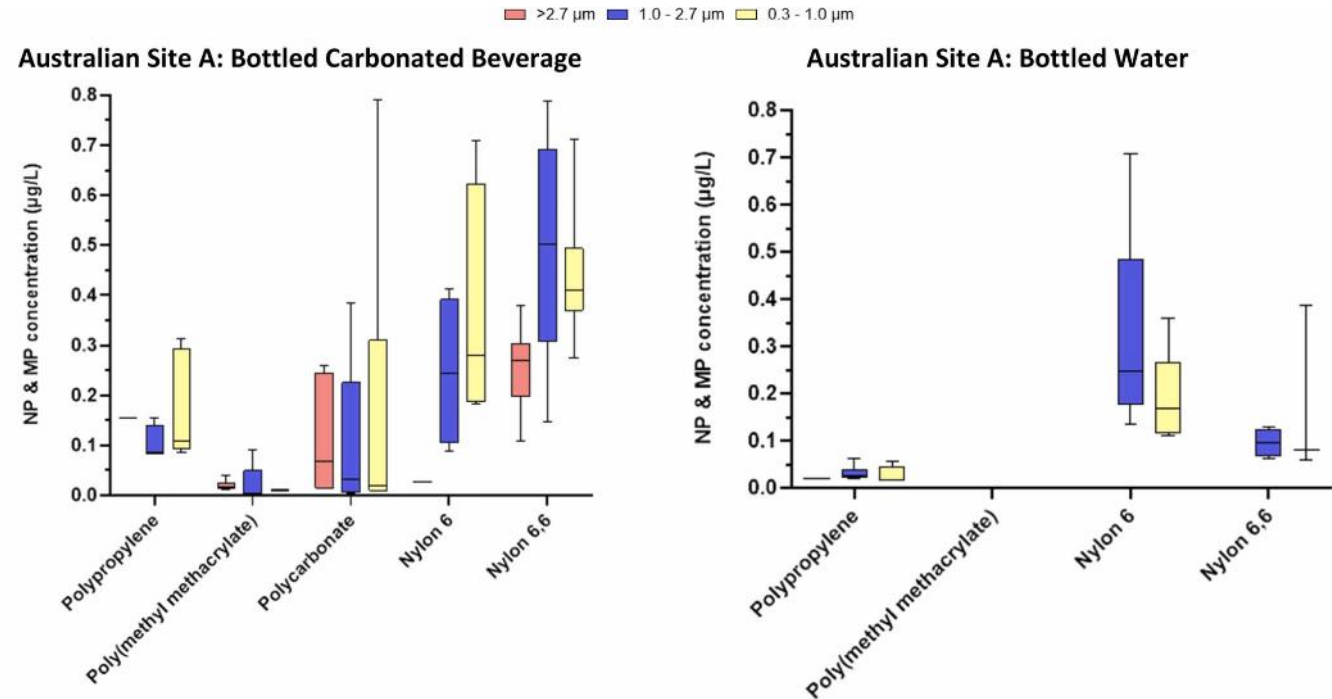
- Majority in 1- 2.7  $\mu\text{m}$  size fraction



Jeffries et al. *ACS Food Sci & Technol.* 2025, 5, 1536-1545

## No similarity between:

- bottled carbonated and bottled water from same manufacturer
- soda fountain beverages and tap water at the same location.

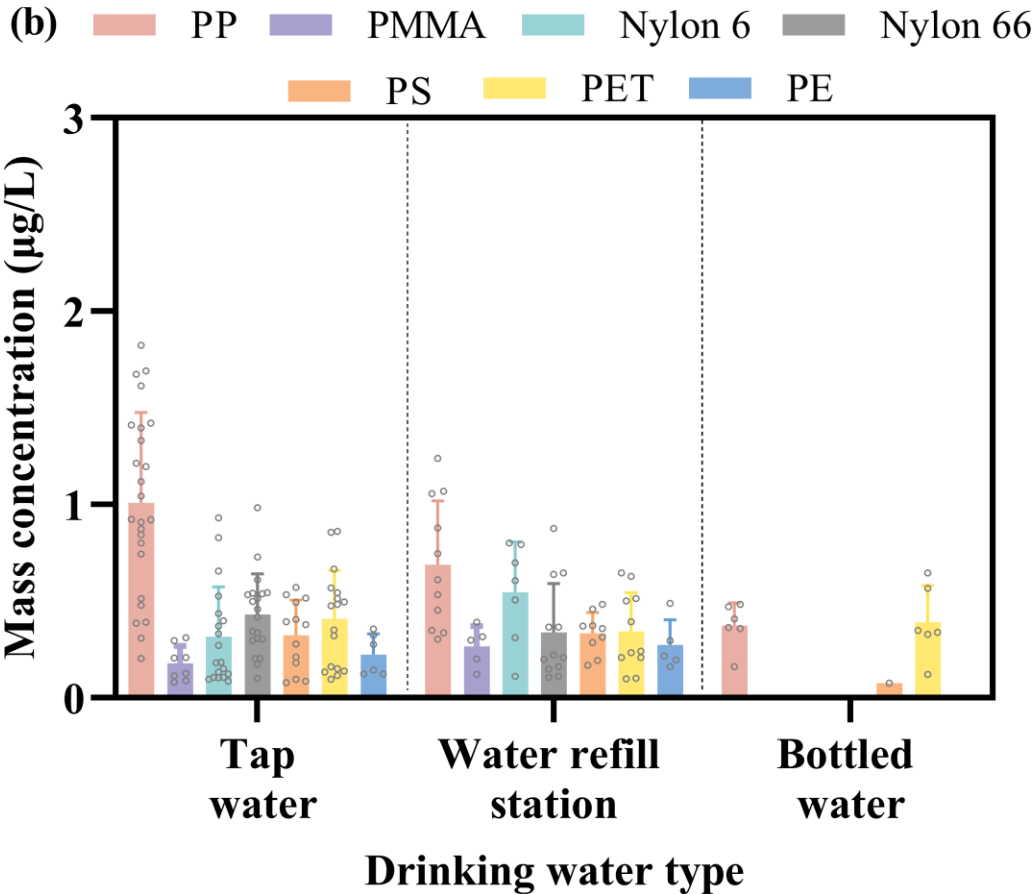
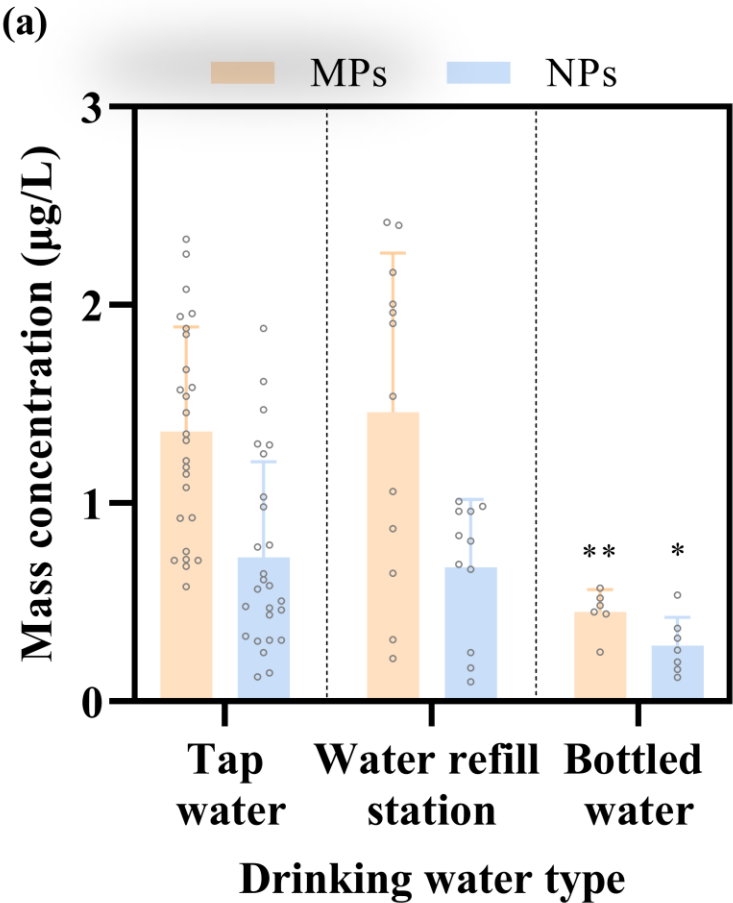


Jeffries et al. *J.HazMat:Plastics*, 2026, 2:100035

# Ingestion: What's drinking water



- PP, Nylon 6, PET
- MPs: 0.5 to 1.5  $\mu\text{g/L}$ ; NPs: 0.3 to 0.7  $\mu\text{g/L}$
  - 200 nm



# Ingestion: Food storage containers

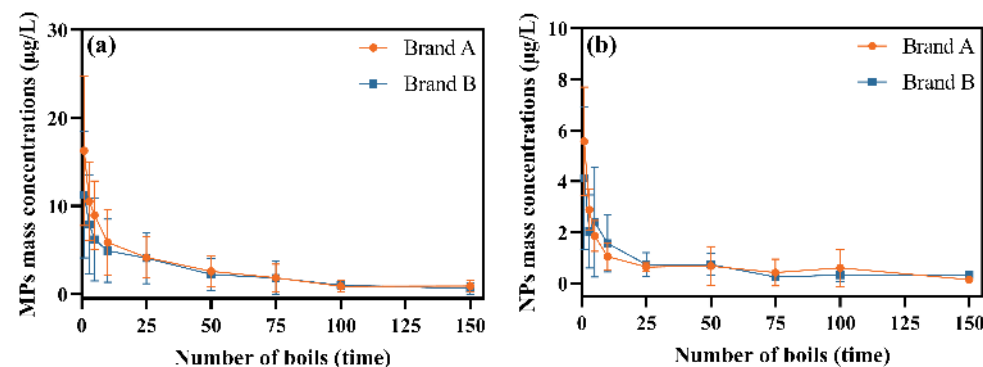
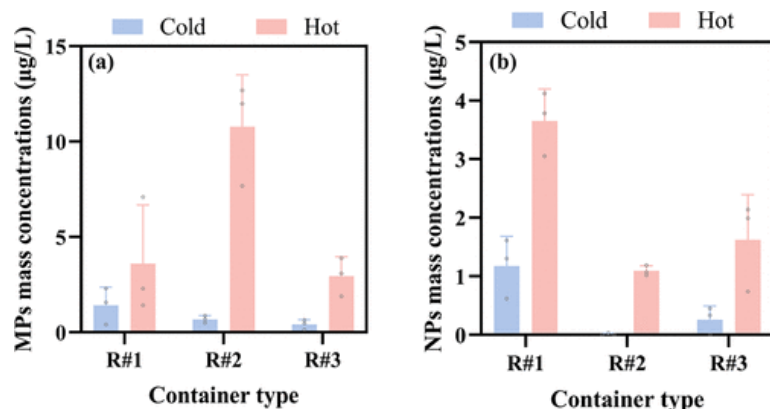


## 1) Food storage containers (PP)

- MPs: 1 - 10  $\mu\text{g/L}$ ; NPs: 0.5 - 4  $\mu\text{g/L}$
- 120-400 nm

## 2) Kettles (PP)

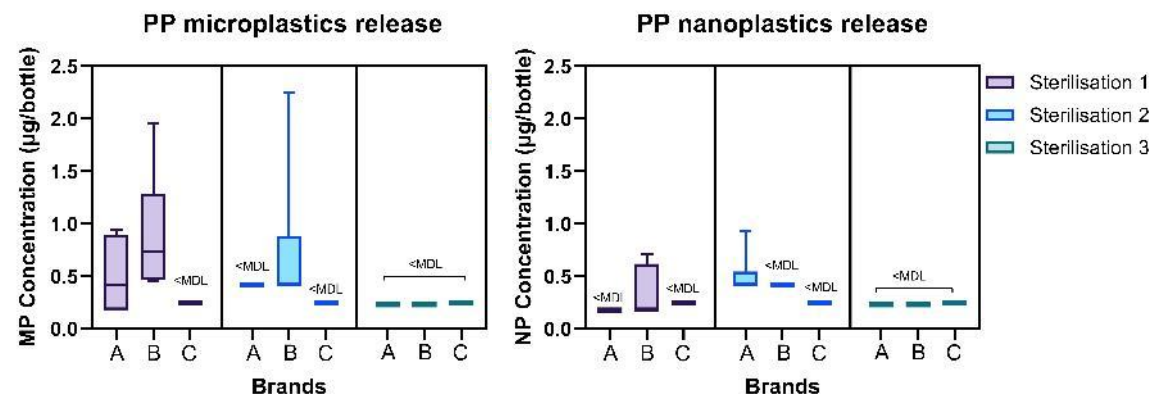
- MPs: 0.3 - 17  $\mu\text{g/L}$ ; NPs: 1 - 5  $\mu\text{g/L}$
- 60-130 nm and 200-300 nm



## 3) Milk storage bottles (PP)

- 0.4  $\mu\text{g}$  - 2  $\mu\text{g/bottle}$

Shi et al., *J. Agric. Food Chem.* 2025, 73, 27038-27047  
Shi et al., *npj Emerging Contaminants*, 2025, 1:16



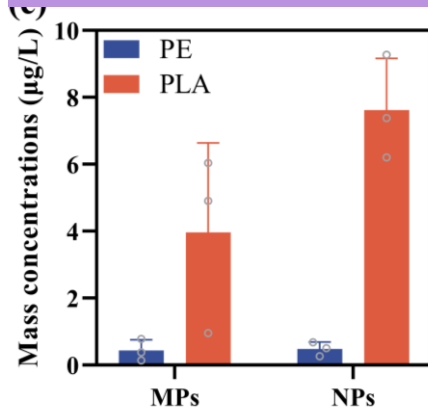
Cruz et al., *In Prep*

# Release of nanoplastics from PLA and PE lined cups

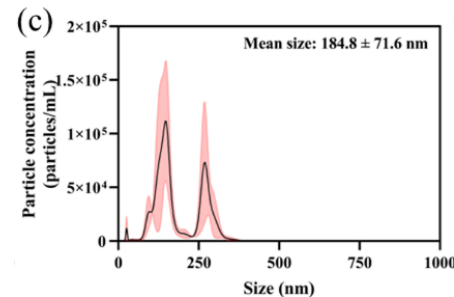


- PLA cups: mean  $11.6 \pm 3.4 \mu\text{g/L}$
- PE cups: mean  $0.9 \mu\text{g/L}$
- PLA 184 nm and PE 168 nm

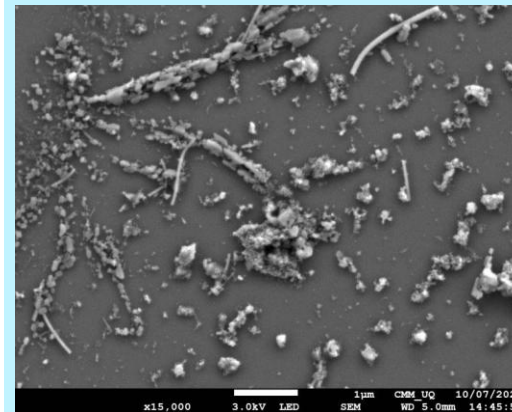
## Concentration



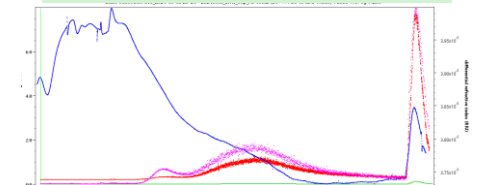
## Particle size



## Morphology

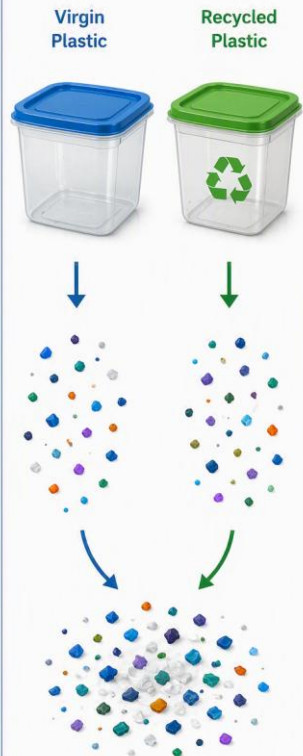


## Particle size-specific polymer concentration

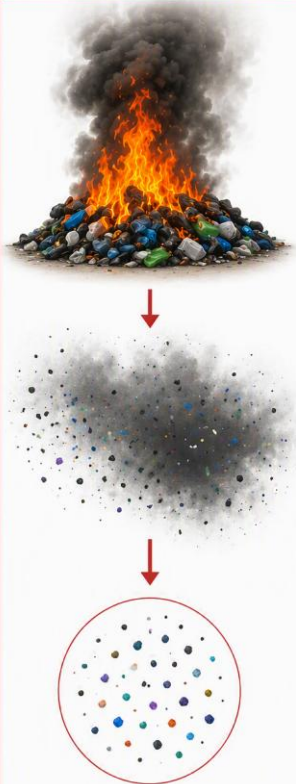


# Release of nanoplastics from key sources

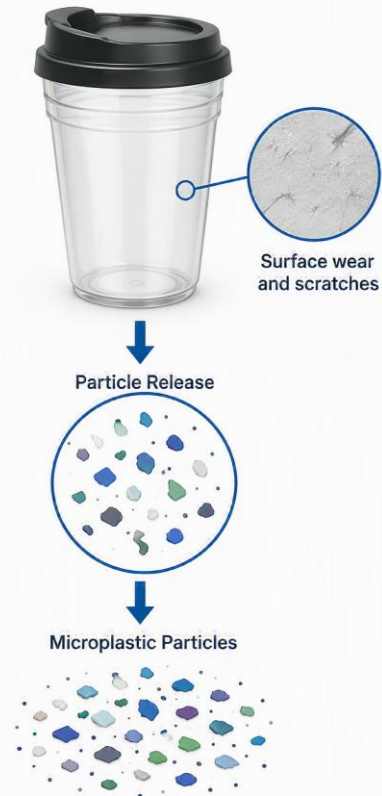
## 1. PLASTIC CONTAINERS Microplastic Release



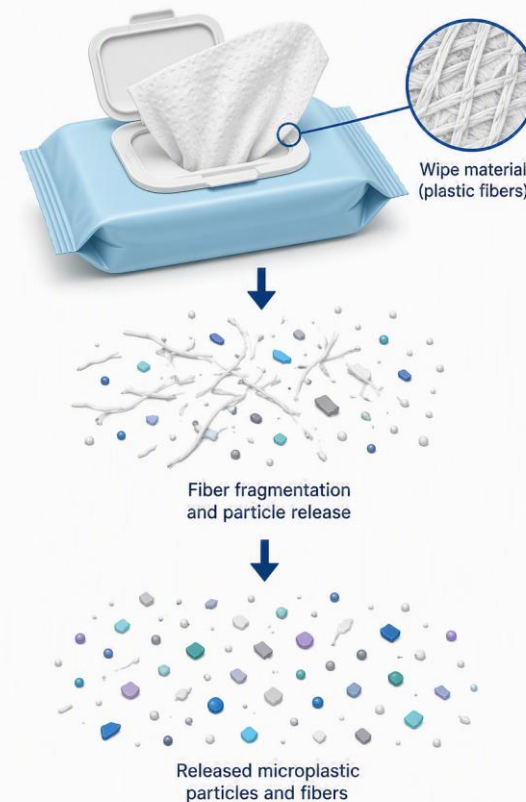
## 2. PLASTIC BURNING Microplastic Release



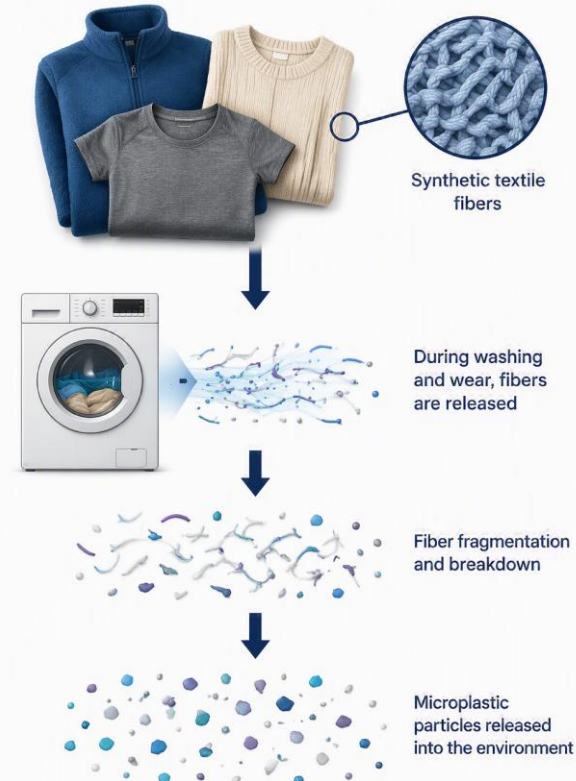
## Reusable Cups



## Wipes Release



## Textiles



# Summary

## **We know we are ingesting/inhaling plastics, we just don't know how much**

- Detect micron and nanosized plastics ubiquitously in drinking water and bottled water
- Food contact materials can shed micron and nanosized plastics into food
  - Increased migration with hot foods
- Do concentrations in human samples match what we are being exposed to?
- Are sizes reported capable of entering the matrix analysed (e.g. crossing biological barriers, ability to translocate in circulatory system etc.)
- Reducing exposure to plastics will require a range of complementary solutions

Source control

Lifestyle changes

# You and the environment: Small actions, big impact



## 1. Reduce Plastic Use

Avoid single use plastics.  
Use reusable alternatives.



## 2. Mind your Laundry & Clothing

Choose natural fibers  
Microfiber filters/washing bags



## 3. Safer Personal Care & Household Products



## 4. Reduce Indoor Air Exposure

Vent dryers, vacuum and ventilate  
regularly



# Acknowledgements



Australian Government  
Australian Research Council



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