# Investigations of micro- and nanoplastic toxicity using a model aquatic invertebrate and a model insect

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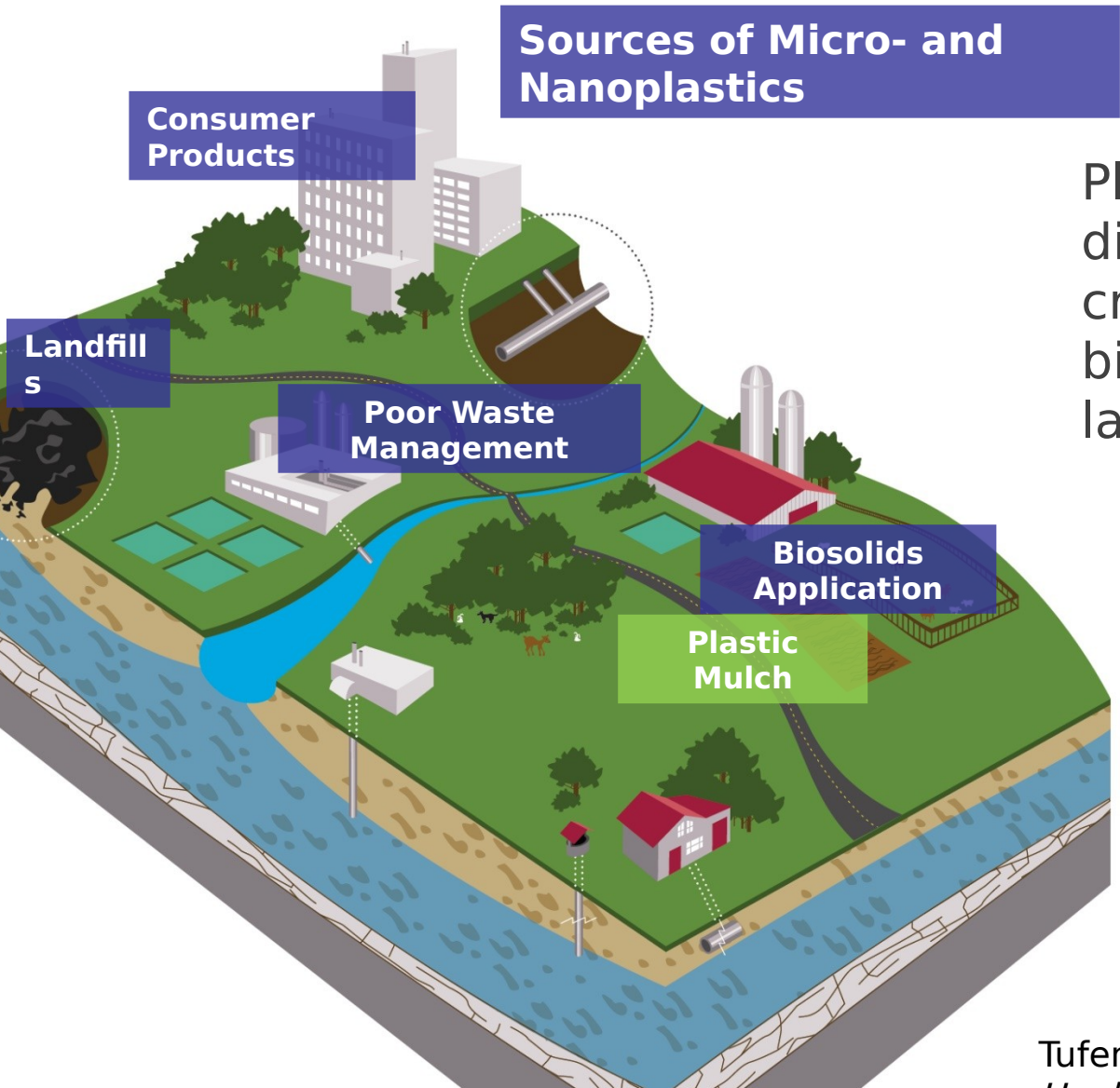
# *Microplastic and Nanoplastic Pollution on Land*

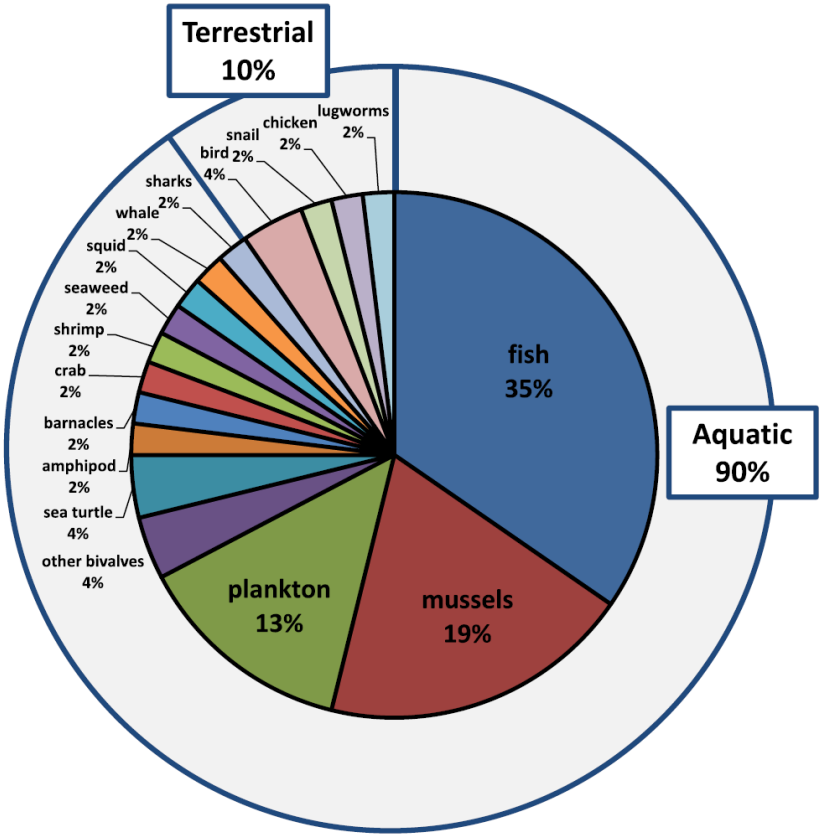



Plastics enter soils via direct application on cropland, wastewater biosolids, release from landfills, etc...

Plastic litter breaks down into secondary microplastics and nanoplastics.

Tufenkji and Emelko *Encyclopedia Env*

# Need for Studies on Freshwater and Terrestrial Animals




Few studies of micro/nanoplastic uptake in terrestrial or freshwater organisms

uyen et al, *Accounts of Chemical Research*, 2019.

## Animal models in this study

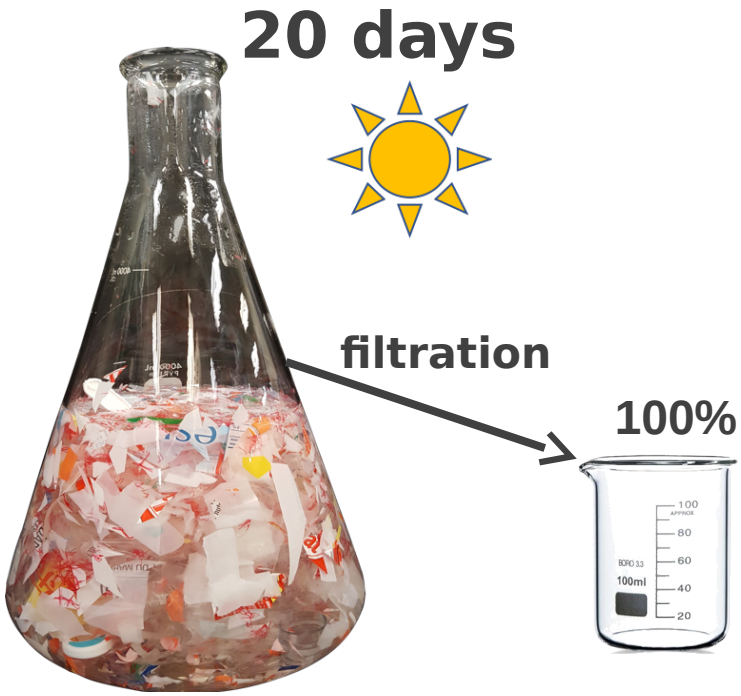
***Daphnia magna* (water flea)**

Transparent, fast reproduction, cheap and easy to work with.

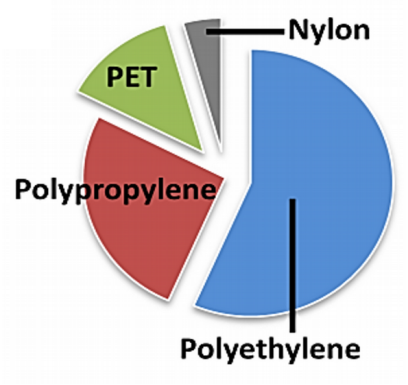
***Drosophila melanogaster* (fruit fly)**

Genetic, proteomic, and physiological similarities to humans

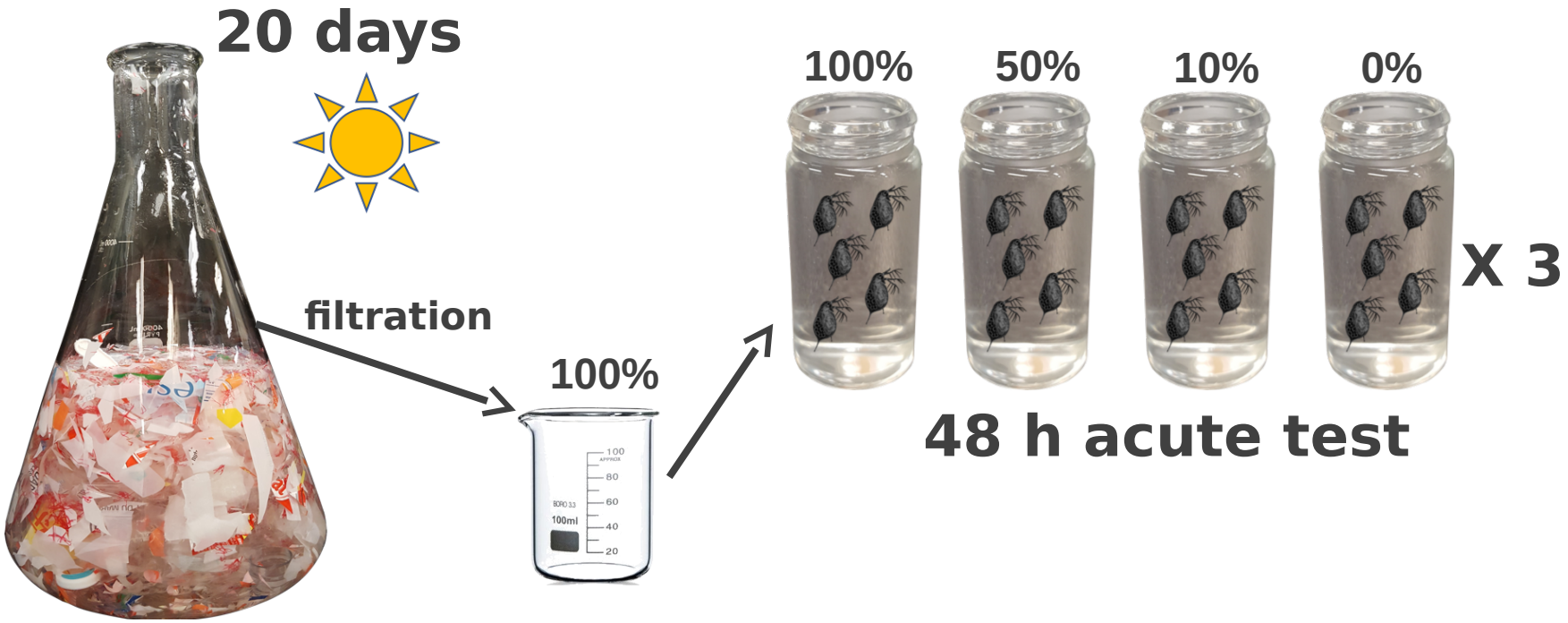
# *Study 1. Chronic Effects of Leachate of Weathered Plastic*




**80 g plastic debris/L**



# *Study 1. Chronic Effects of Leachate of Weathered Plastic*

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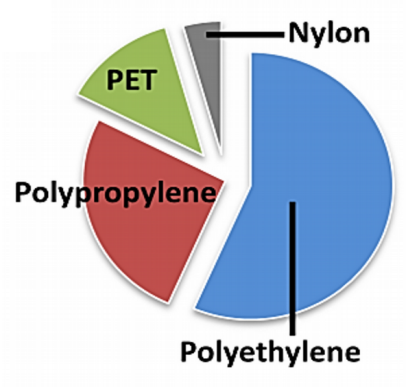


# *Study 1. Chronic Effects of Leachate of Weathered Plastic*

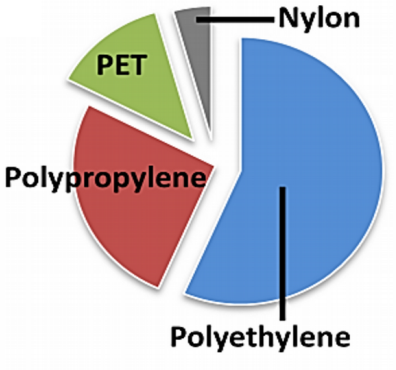
**20 days**

**filtration**

**100%**

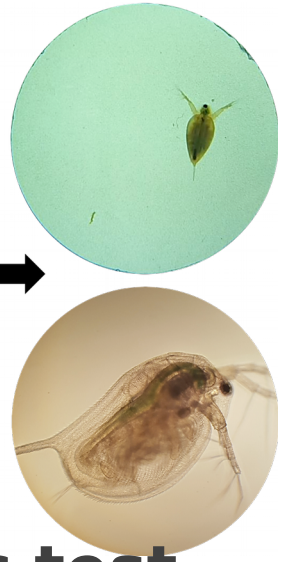

**48 h acute test**

**80 g plastic debris/L**




**100%**

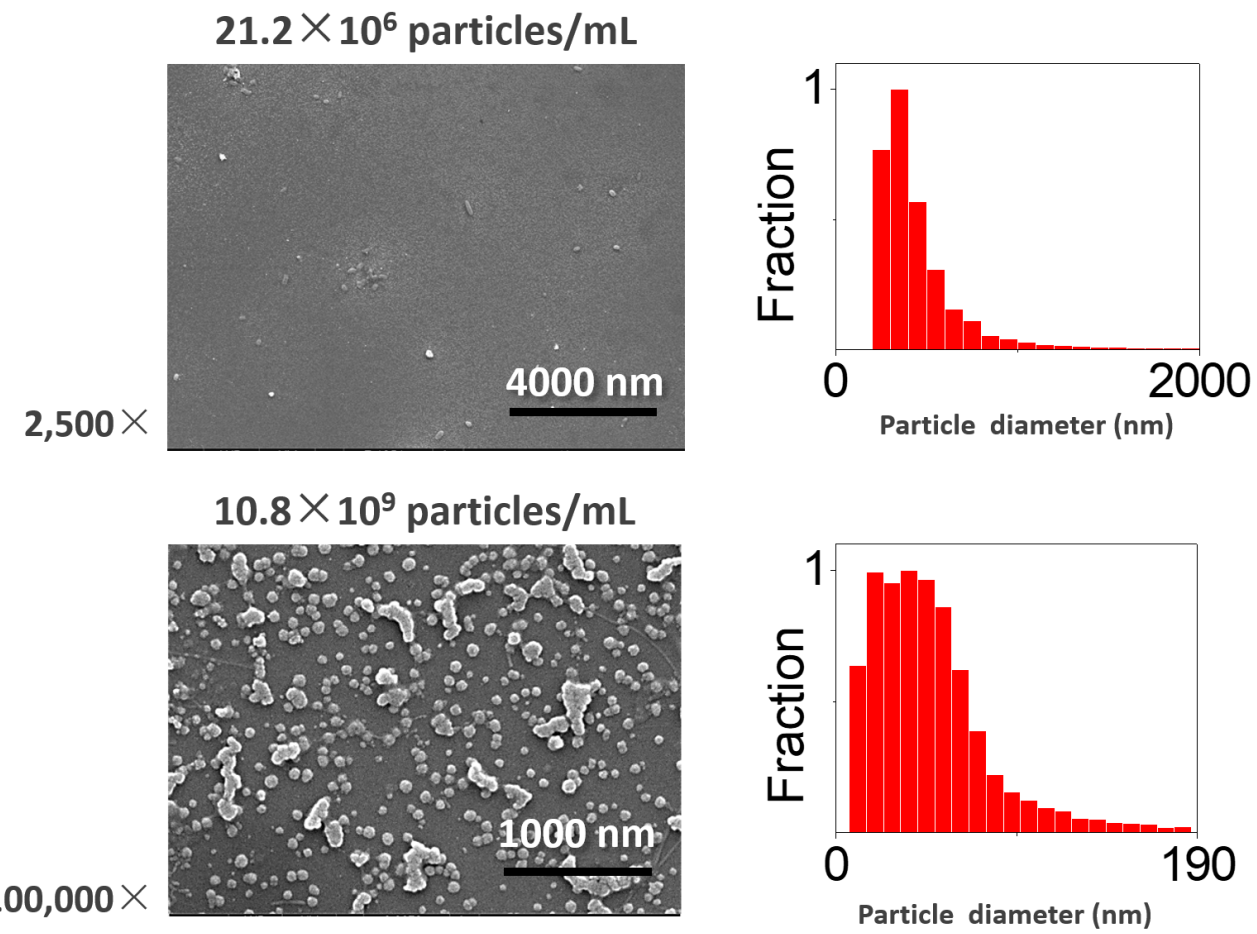
**X 10**



**0%**

**10 day chronic test**

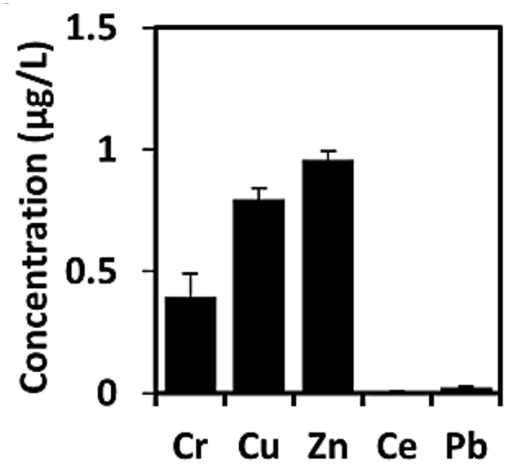
# *Secondary Microplastics and Nanoplastics in Leachate*

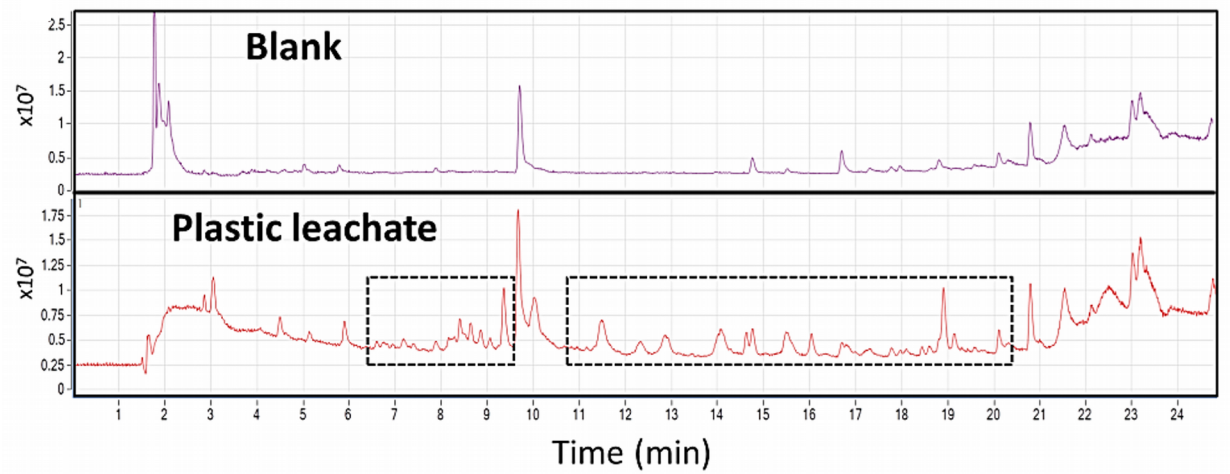



There are 500 times more nanoplastics than microplastics.

et al, *Environmental Science: Nano*, under review.

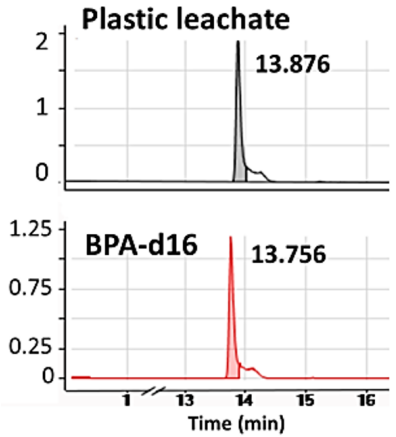
# *Plastic Leachate Contains Low Metals but Complex Organics*



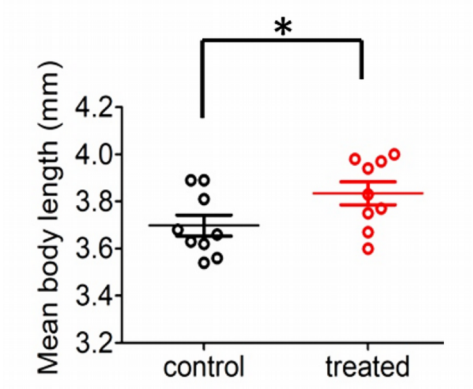

Several metals are detected at concentrations < $LC_{50}$ in *Daphnia*.

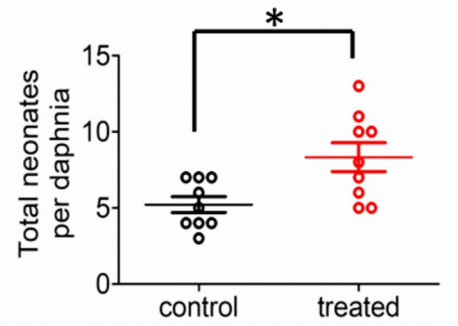
A complex mixture of organic compounds, including bisphenol A is released from the plastics.

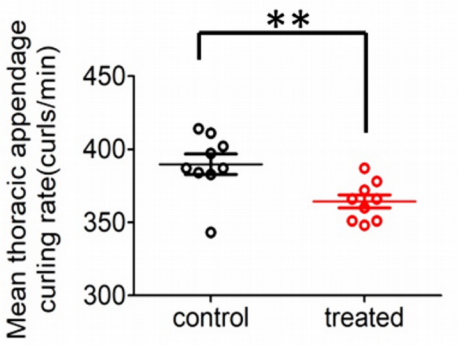


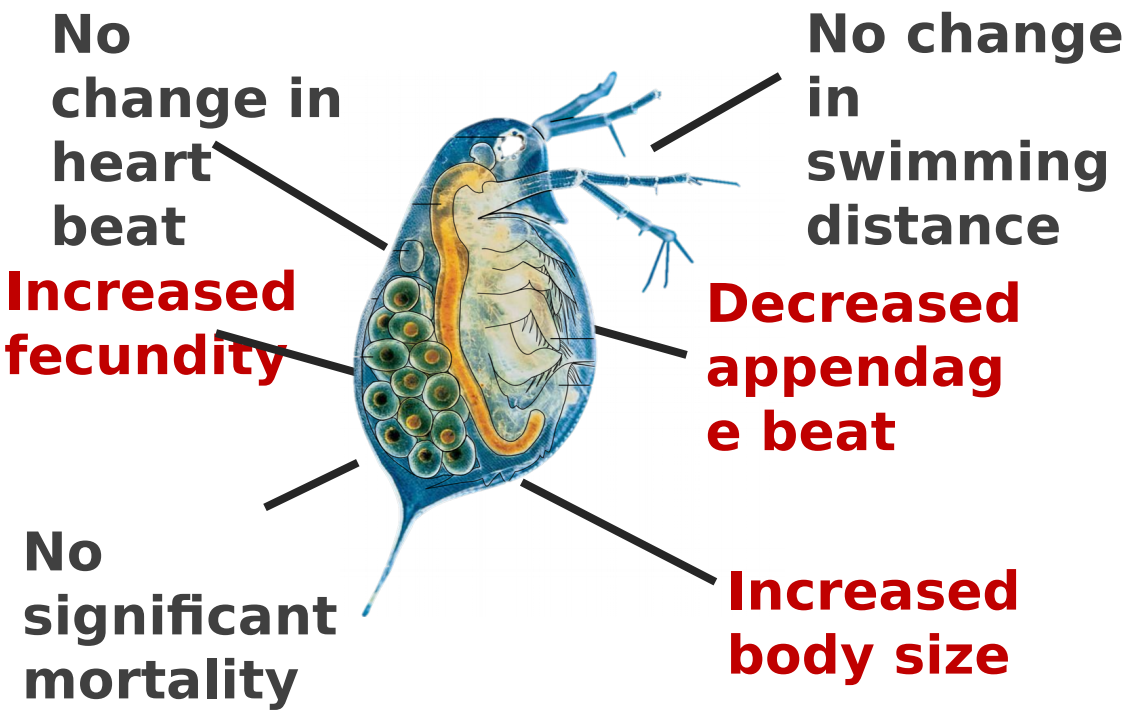

et al, *Environmental Science: Nano*, under review.

# *Leachate Affects Growth, Reproduction, and Physiology*



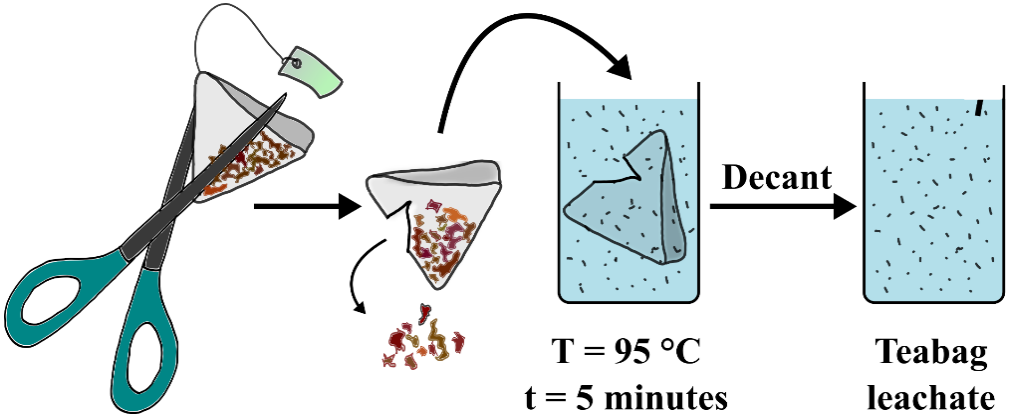




Observed sublethal effects due to mixture of microplastics, nanoplastics and leached chemicals.

Xu et al, *Environmental Science: Nano*, under revi

# *Study 2. Acute Effects of Food Packaging Debris*

plastic teabags

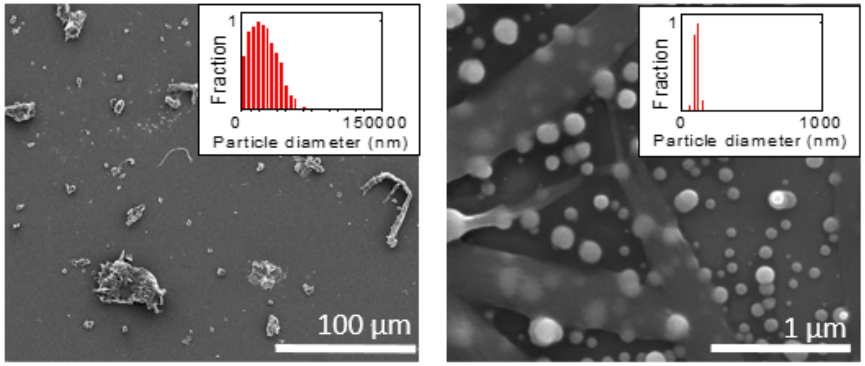



372 g
plastic
packaging/L

rnandez et al, *Environ. Sci. Technol.*, under review.

# *Food Packaging Releases High Levels of MPs and NPs*

Dried Teabag Leachate




mean diameter ~ 25 µm

~ $2 \times 10^6$ particles/teabag

mean diameter ~ 100 nm

~ $15 \times 10^9$ particles/teabag

When drinking 1 cup of tea, a person can ingest:

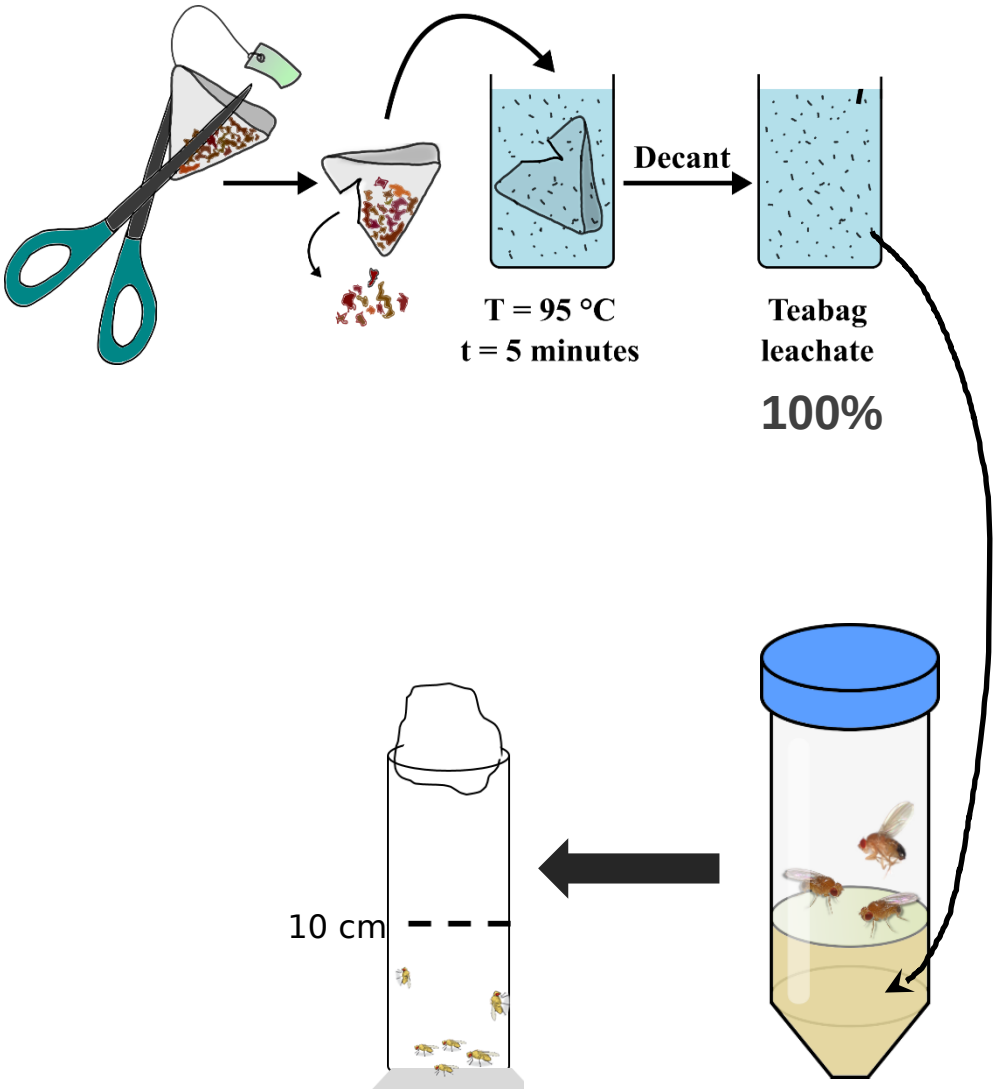
2 million micro-sized plastics

15 billion sub-micron plastics

rnandez et al, *Environ. Sci. Technol.*, under review.

# *Study 2. Acute Effects of Food Packaging Debris*

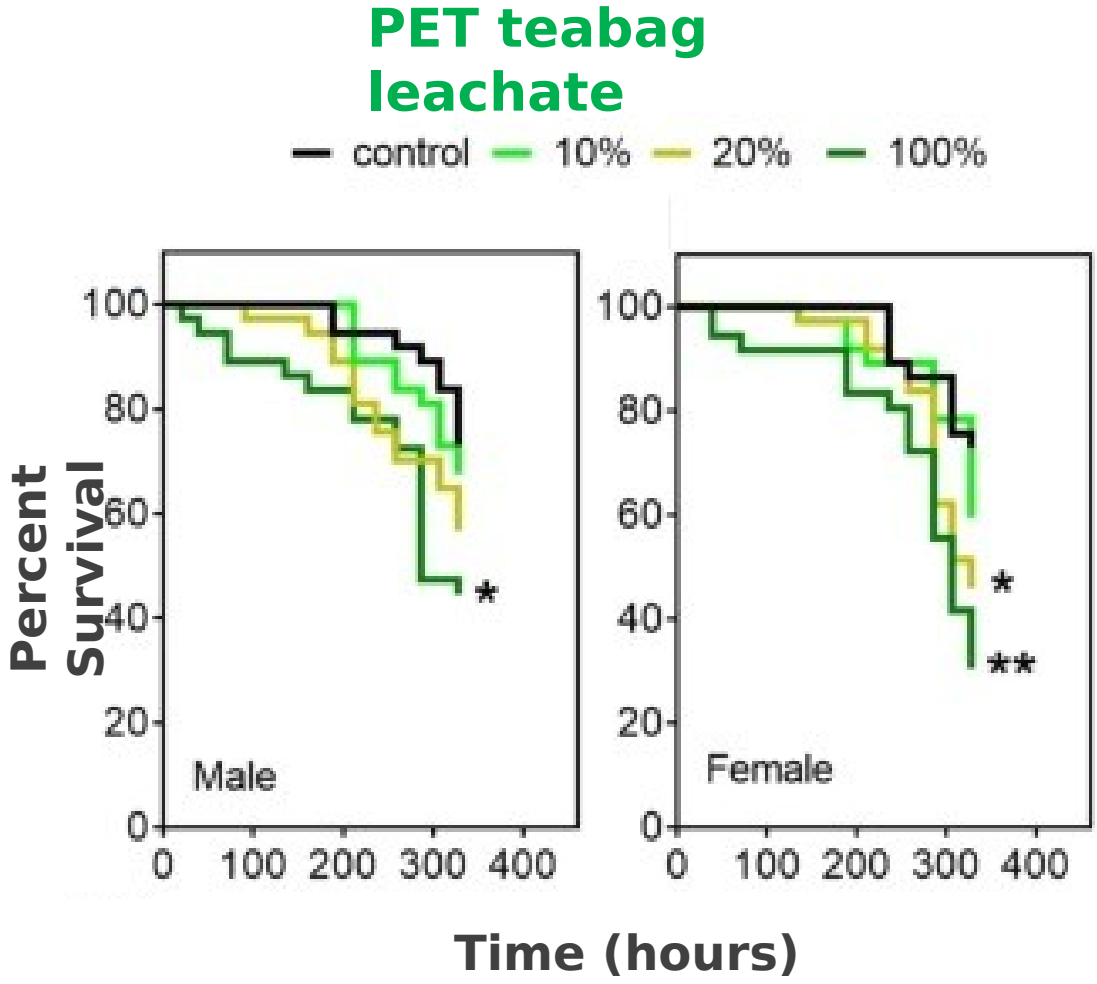
plastic teabags




climbing assay

rnandez et al, *Environ. Sci. Technol.*, under review.

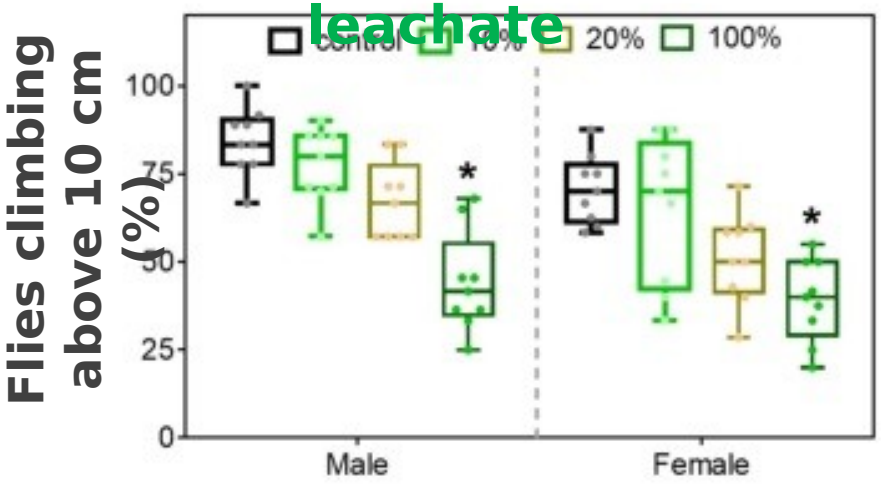
# *Food Packaging Debris Affects Fly Survival and Behavior*



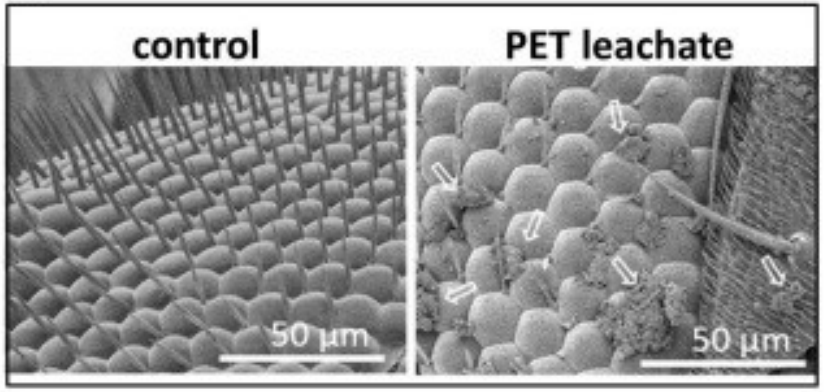

Female flies are more susceptible than male flies.

# *Food Packaging Debris Affects Fly Survival and Behavior*

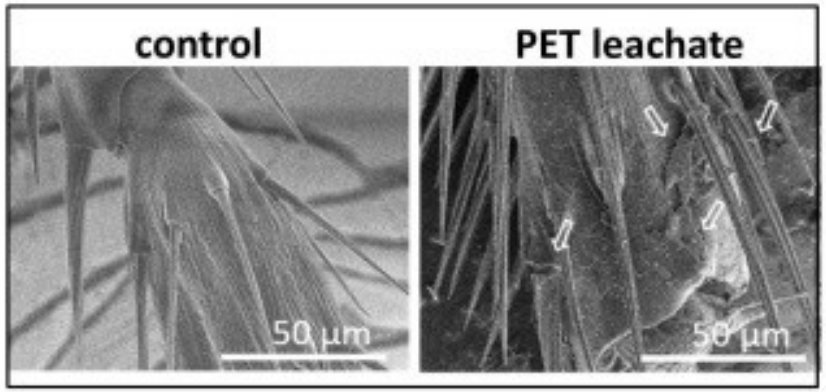
**PET teabag leachate**




SEM of fruit fly eyes




SEM of fruit fly legs



# *Concluding Remarks*

- Bulk plastics can degrade into millions of microparticles and billions of nanoparticles
- Weathered plastic leachate can exhibit low toxicity but can impact growth, reproduction and feeding behavior.
- Plastic use in food packagings can lead to undesirable contamination of foods with high levels of micro- and nanoplastics

# *Acknowledgements*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Prof. Stephane Bayen



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Canada Foundation for Innovation
NSERC
McGill University Faculty of Engineering

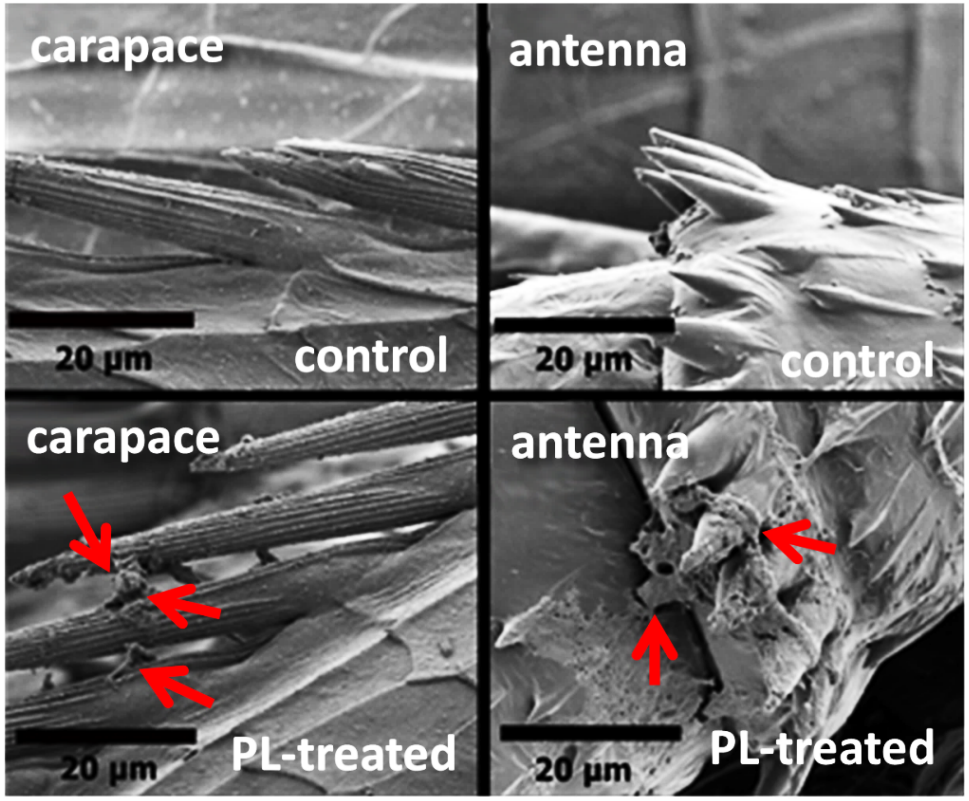

We have a funded postdoc position in ecotoxicology. Please contact me!

**visit us: www.biocolloid.mcgill.**

Extra Slides

# *Microplastics and Nanoplastics on Daphnia*

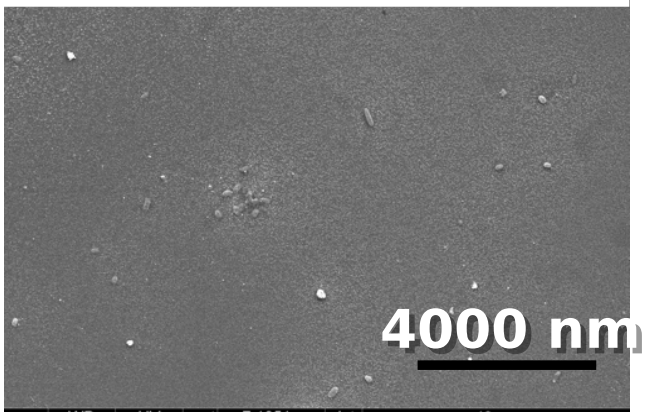
Scanning electron microscopy is used to image plastic particles on the carapace and antenna of *Daphnia*.



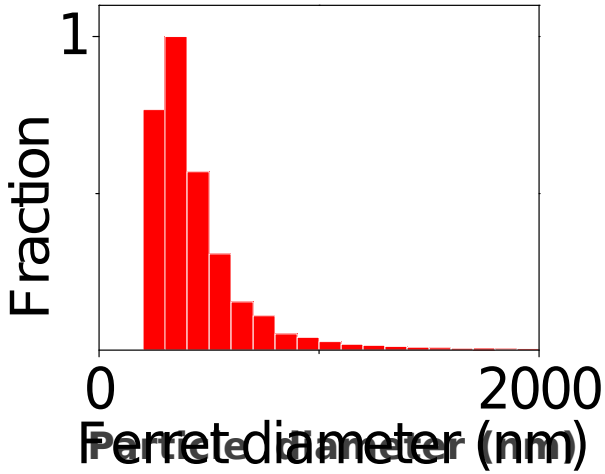

et al, *Environmental Science: Nano*, under review.

# *Secondary Microplastics and Nanoplastics in Leachate*

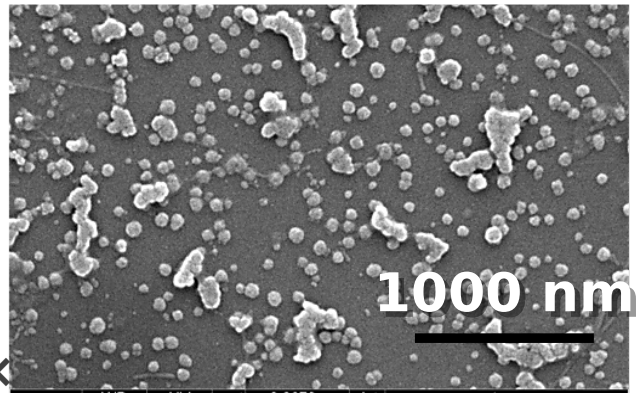
**21.2×10⁶ particles/mL**



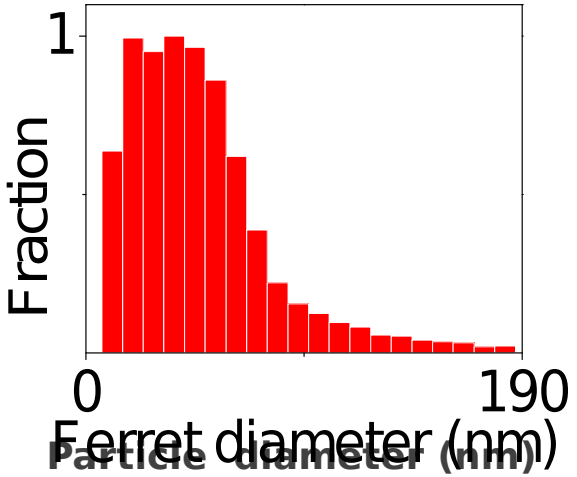

2,500×




**10.8×10⁹ particles/mL**




100,000×




et al, *Environmental Science: Nano*, under review.

# *Chemical Contaminants in Leachate*

| Proposed formula | Tentative identity |
|---|---|
| **ESI+** | |
| $C_9H_{19}NO_4$ | Dexpanthenol |
| $C_8H_{19}NO_2$ | N-Butyldiethanolamine |
| $C_{17}H_{26}O_3$ | 4-Nonylphenoxyacetic acid |
| $C_{20}H_{34}O_4$ | 1,4-Bis{2-[(2-methyl-2-propanyl)peroxy]-2-propanyl}benzene |
| $C_{22}H_{30}O_4$ | Bis(4-methylcyclohexyl) phthalate (4-Methalate) |
| $C_{22}H_{30}O_4$ | Bis(4-methylcyclohexyl) phthalate (4-Methalate) |
| $C_{20}H_{30}O_2$ | Abietic acid |
| **ESI-** | |
| $C_7H_8O_3S$ | Toluene sulfonic acid |
| $C_{13}H_{22}O_4$ | Dibutyl itaconate |
| $C_7H_7NO_3$ | 5-Aminosalicylic acid |
| $C_{13}H_{16}O_4$ | Monopentyl phthalate |
| $C_{20}H_{22}O_3$ | Avobenzone |
| $C_{12}H_{16}O_3$ | 2,2-Diethoxyacetophenone |
| $C_{15}H_{16}O_2$ | Bisphenol A (BPA)* |
| $C_{20}H_{34}O_4$ | 1,4-Bis{2-[(2-methyl-2-propanyl)peroxy]-2-propanyl}benzene |
| $C_{20}H_{30}O_2$ | Abietic acid |

et al, *Environmental Science: Nano*, under review.