IMPROVING MICROPLASTIC RESEARCH

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HOW MANY ARE OUT THERE? IF YOU DO COUNTING STUDIES

- Studies from all around the world count MPs in water and sediment. Can’t compare or see trends over time – no standard methods!!
- Should you collect with a (plankton) net or evaporate water samples?
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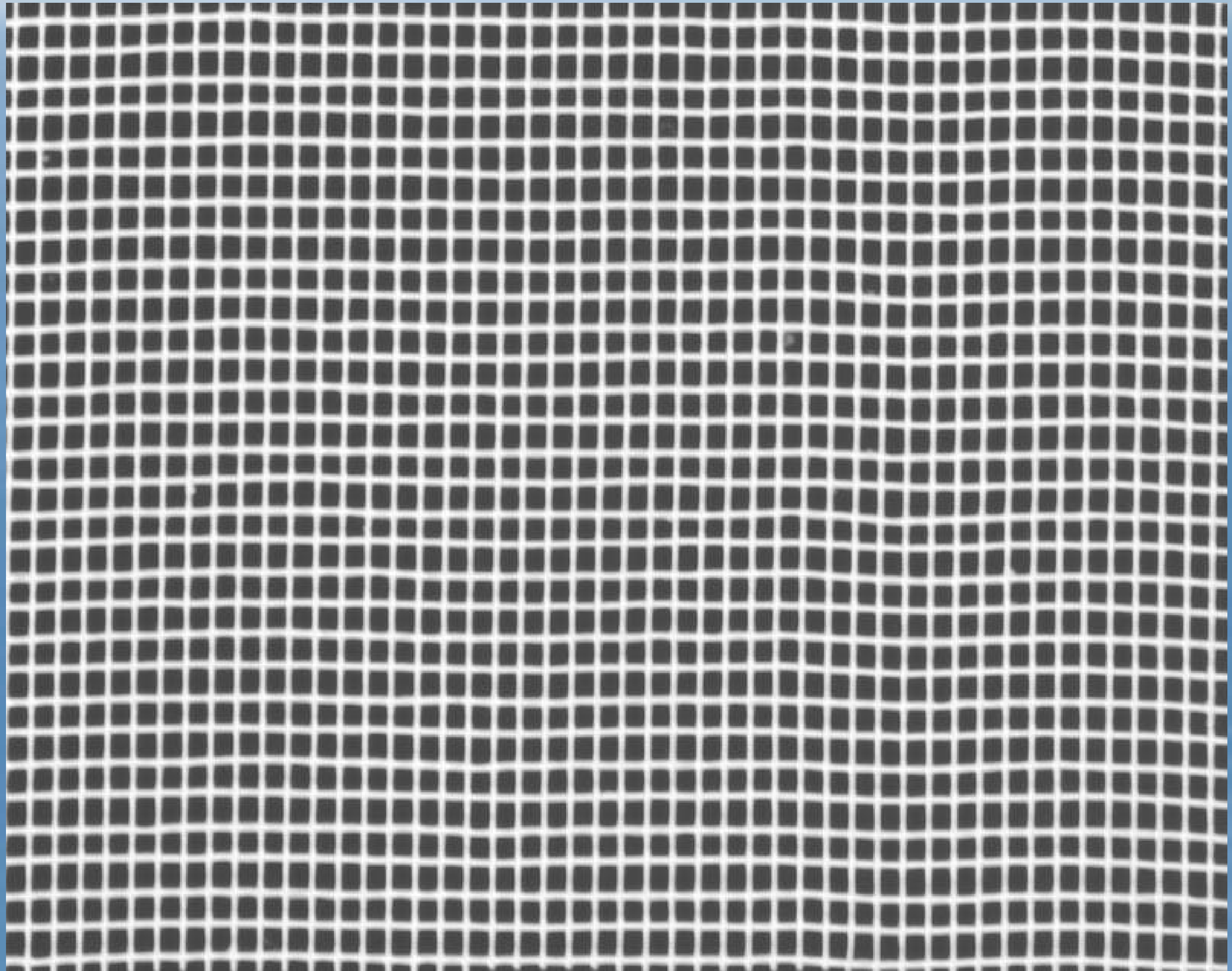
NOT ALL PLANKTON ARE CAUGHT IN NET

Elongated thin shapes go through net much of the time



SHAPES OF MICROPLASTICS

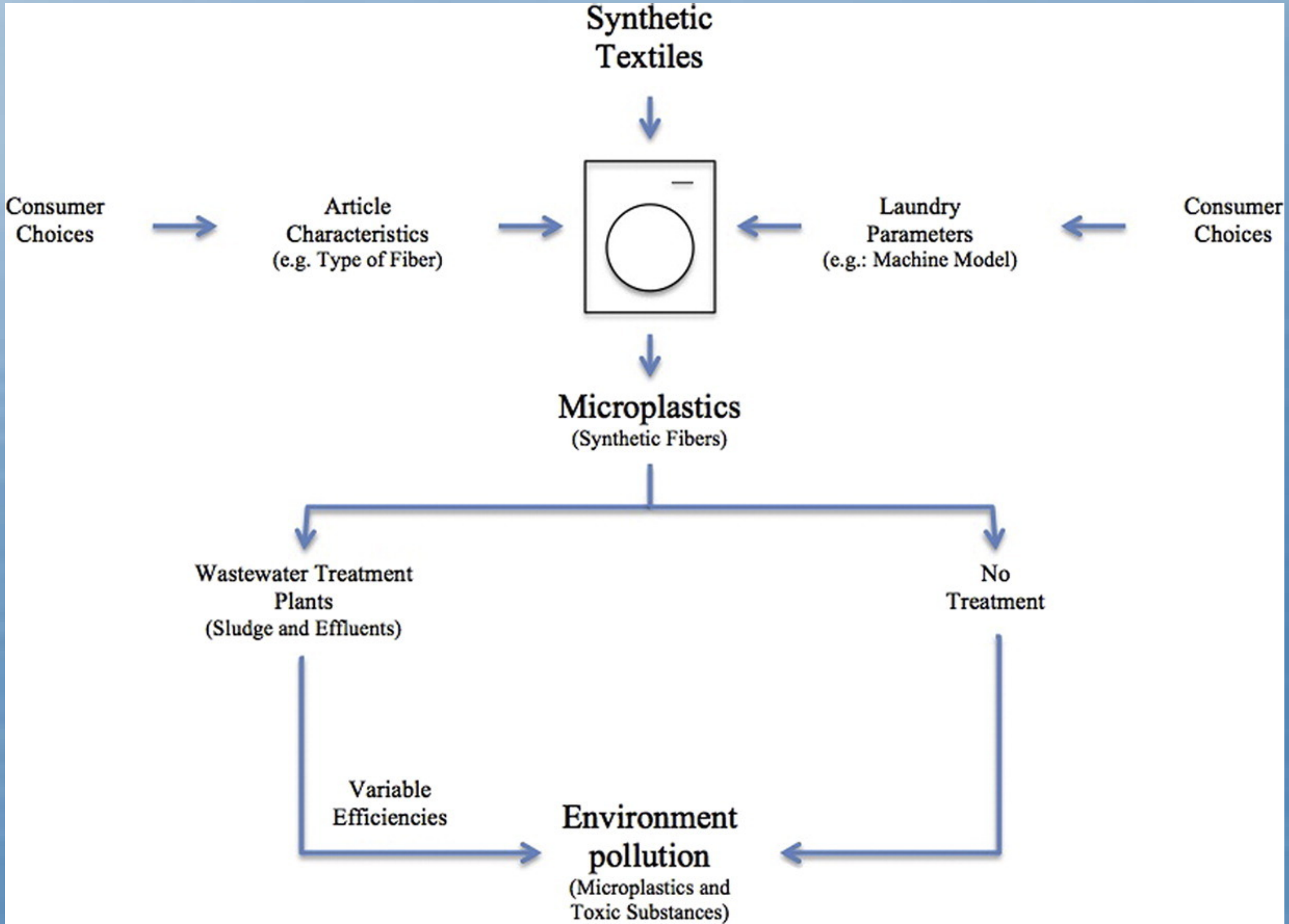
A MICROFIBER UNDER THE MICROSCOPE. (PHOTO CREDIT: CAITLIN WESSEL)

Whole water samples show microfibers are by far the most abundant (<80%). Samples from nets - microfibers much less abundant. Green et al. 2018: manta, bongo and plankton nets may underestimate concentrations of microplastic fibers by **3 to 4 orders of magnitude** compared to grab method

Meta-analysis: “average sample composition in the water column was 52% fibers, followed by 29% fragments, with other particle morphologies including beads/spherules, films, foams, and others making up only a small proportion”

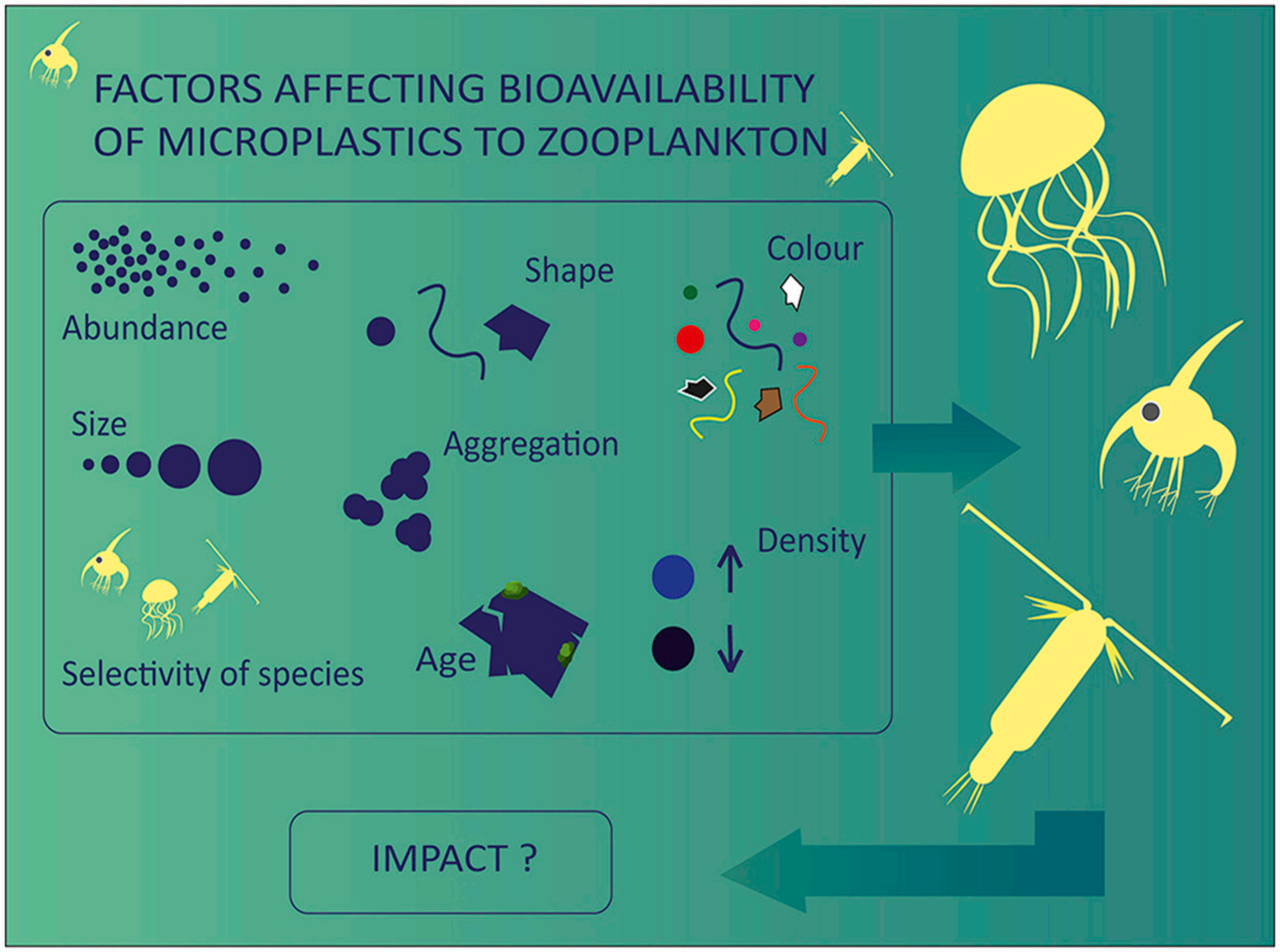
IUCN GLOBAL REPORT

Close to 2/3 of the releases are due to the laundry of synthetic textiles (34.8%), and to the erosion of tires while driving (28.3%). The third important contribution (24.2%) is City Dust. Personal care products only account for 2% of the global release of primary microplastics to the world ocean.

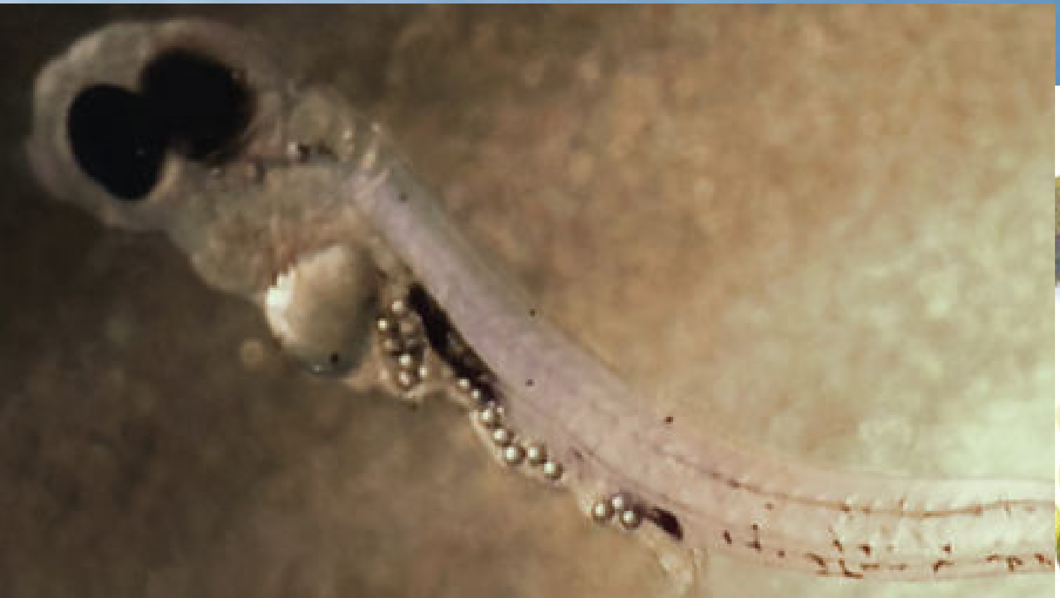


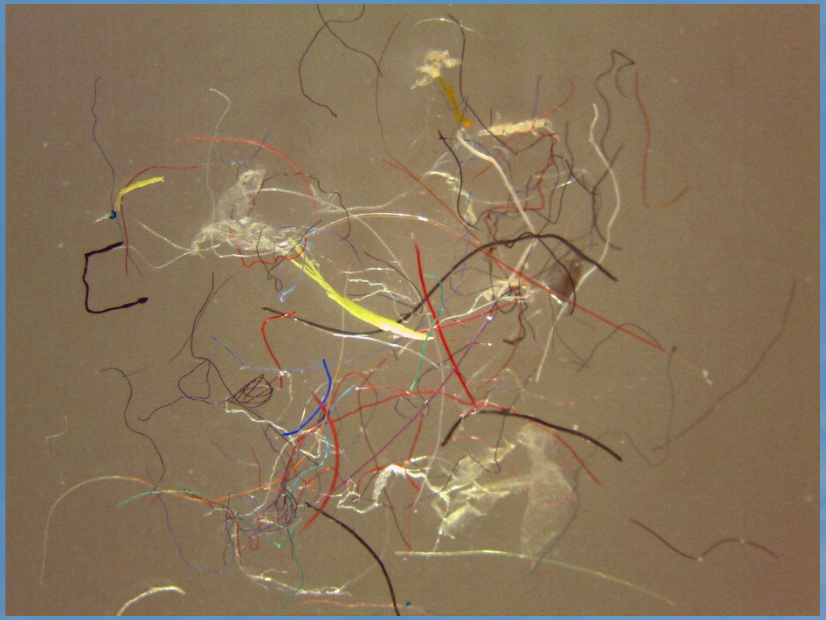
CONSIDER MPS AS SUITE OF CONTAMINANTS

- Differ in shape (fibers, fiber bundles, fragments, nurdles, spheres, films foams), color, chemistry, and size. Different sources, behavior in the environment, and effects.



ANIMALS CONSUME MICROPLASTICS
WHICH SHAPE MOST LIKELY TO GO THROUGH GUT AND OUT WITHOUT CAUSING PROBLEMS?
WHICH MORE LIKELY TO CAUSE TISSUE DAMAGE?
WHICH MORE LIKELY TO CLOG UP THE GUT?





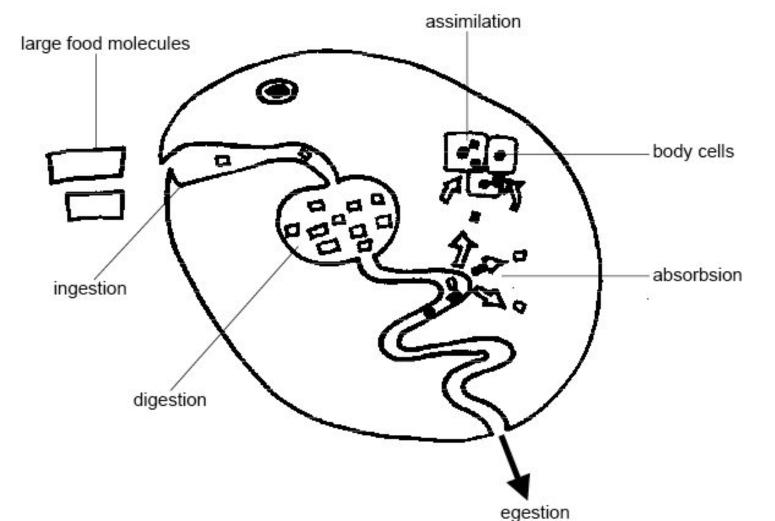
IN ORGANISMS

Most MPs in animals fibers and fragments, small proportion beads. Most from the gut

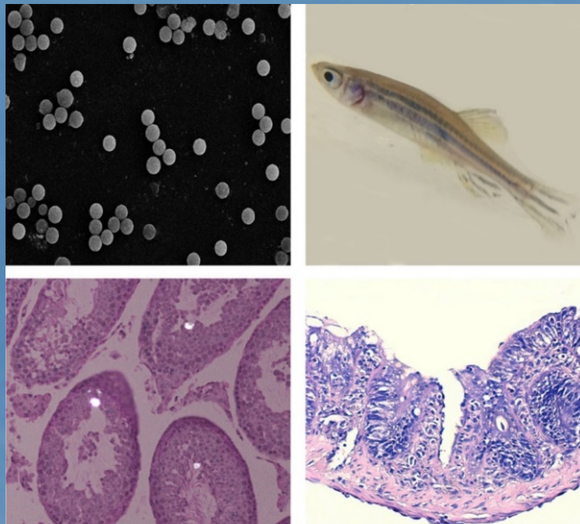
Fibers could be high for 2 reasons: (1) concentrations reflect environment composition and/or (2) fibers not egested as efficiently as other particles

Study **egestion** along with ingestion! Numerous laboratory studies on ingestion, few on egestion, particularly at concentrations similar to environmental levels.

Few observations of MPs moving from digestive tract. *D. magna* exposed to 1-mm spheres showed translocation across the gut epithelial barrier (Rosenkranz et al. 2009). Crabs exposed to 0.5-mm spheres showed translocation to the hemolymph, gills, and ovary (Farrell and Nelson 2013).



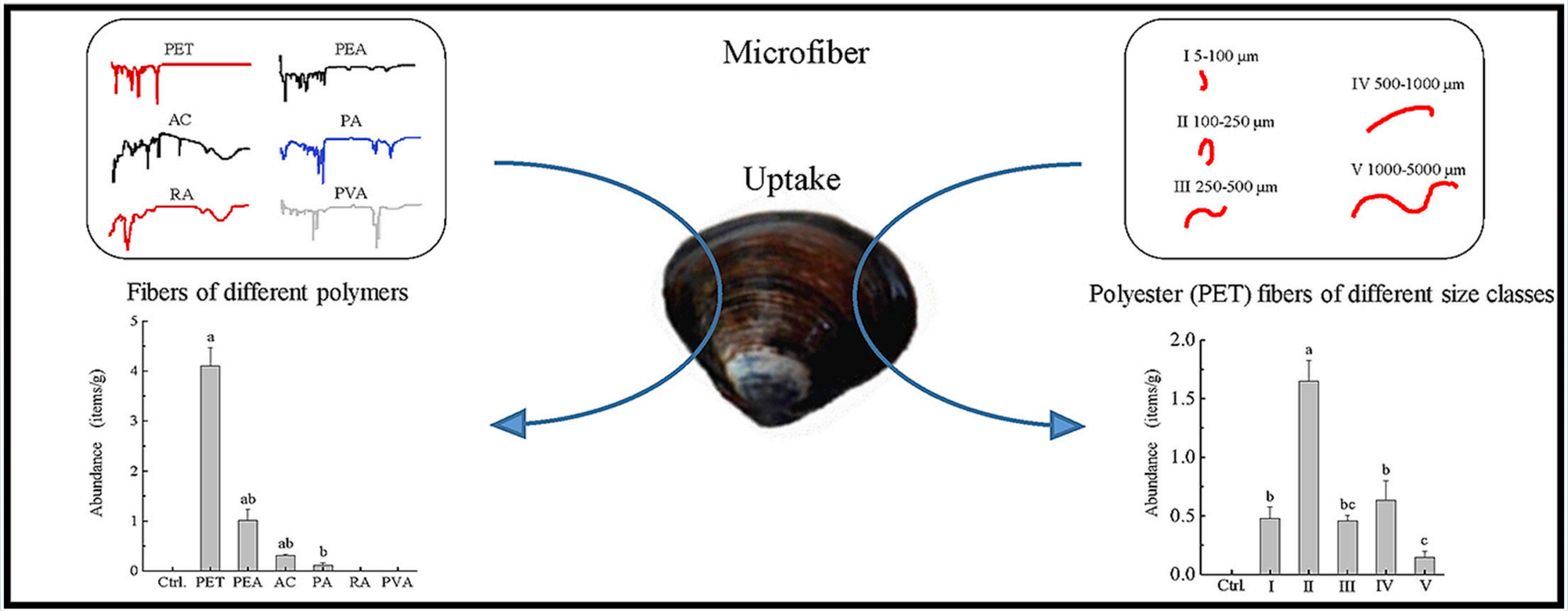
Materials found in gut are not truly IN the animal. Degree and rate of egestion will depend on complexity/morphology of the digestive tract + shape, size etc. of the particle



BIVALVES

- Mussels and other filter-feeding bivalves reject undesirable particles during or after capture by means of pseudofeces. Most MPF (71%) found in pseudofeces at all experimental MPF concentrations. Another ~10% found in feces after passing through digestive system (Woods et al. 2018).

DIFFERENT POLYMERS AND SIZES ARE TAKEN UP DIFFERENTLY LI ET AL 2019



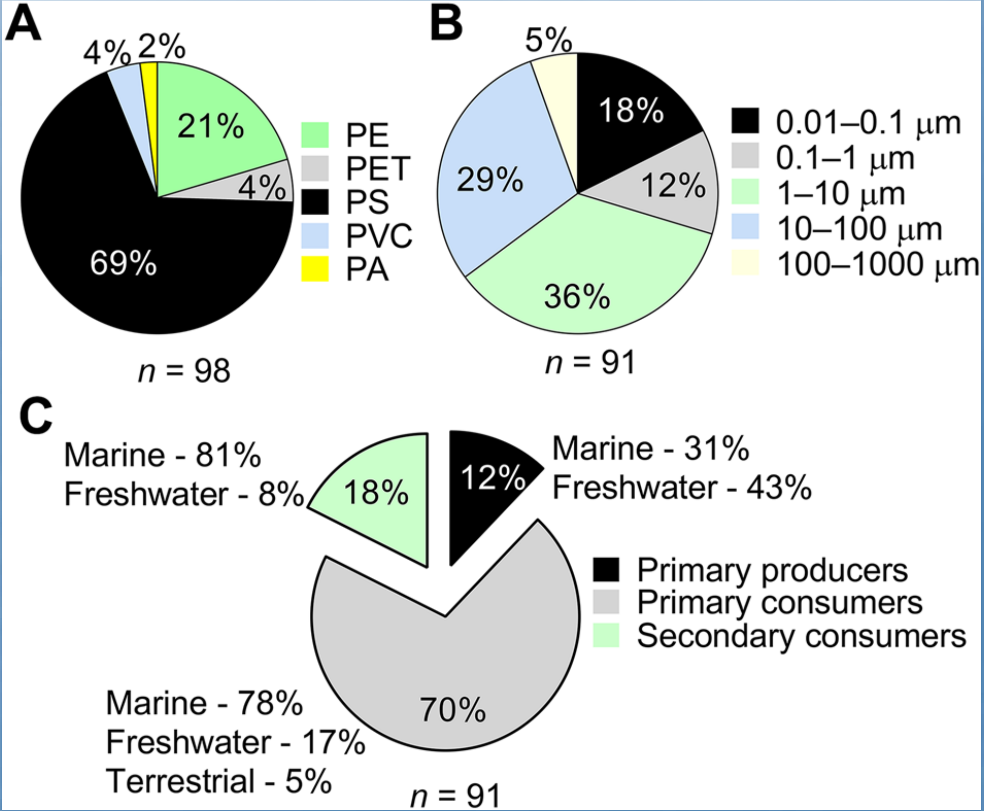
TROPHIC TRANSFER

Demonstrated in the laboratory but invertebrate prey fed only MPs, which could influence uptake; then fed to predators prior to egestion; then MPs measured in predators prior to egestion despite high egestion rates.

Assess to what degree MPs of different types, sizes, and shapes can be transferred from gut to tissues of animals and then through food web to humans. Combine with real food and allow time for egestion.

EFFECTS

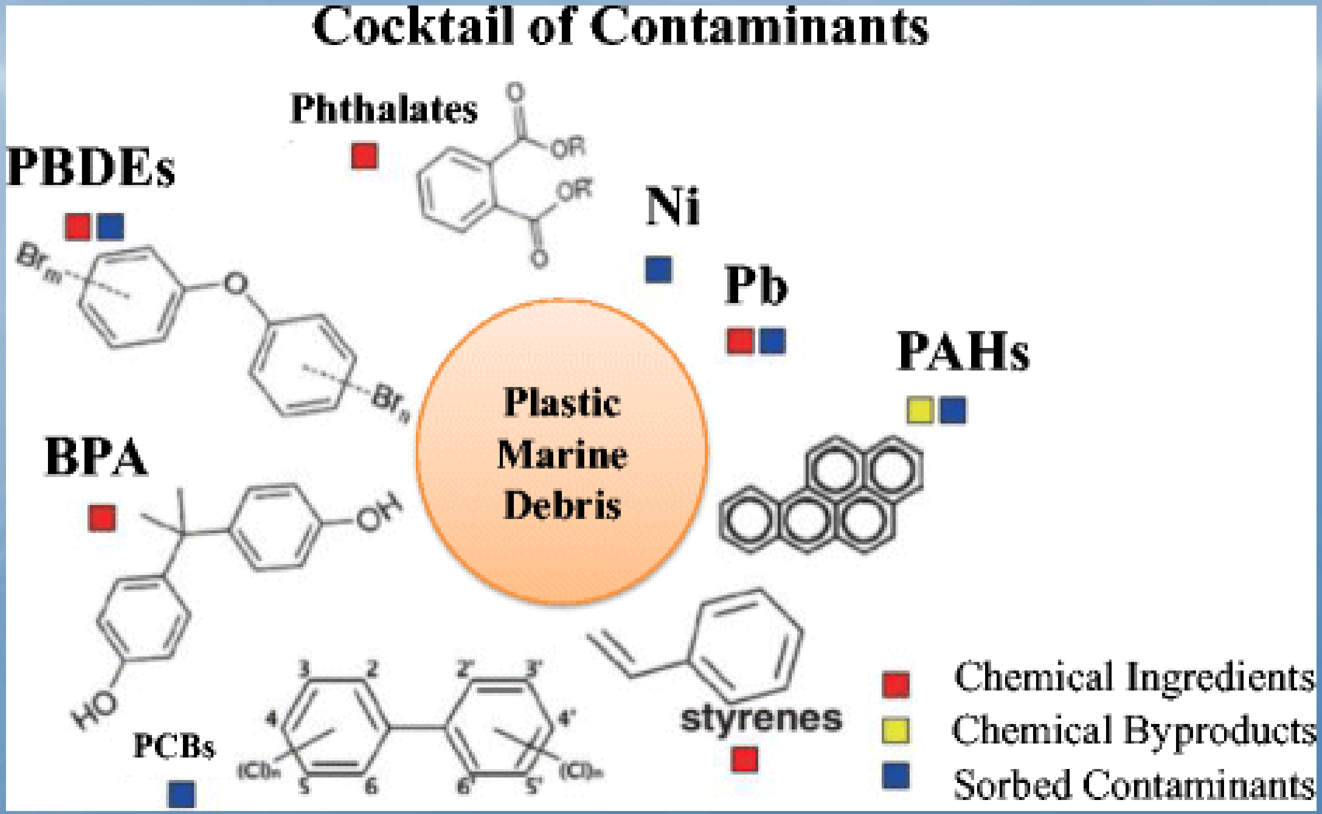
Most common test material is polystyrene, despite polyethylene reported as the most common polymer in samples; most studies (95%) used smaller particle sizes than those that can be confidently detected in the environment; most studies focus on spheres, with few testing fibers or fragments despite prevalence of fibers and fragments in environment



RESULTS

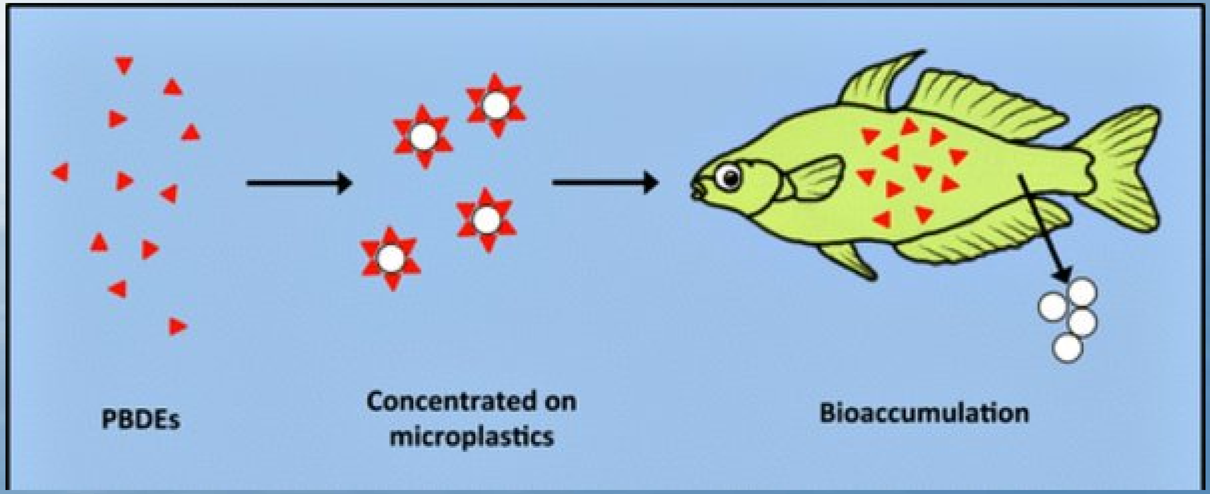
- Some MPs may adversely affect organisms exposed to high concentrations
- Mismatch between size, morphology, and concentration of microplastics in effects studies and those in environment, where MPs are a mixture. Ecotox studies should test fibers, fragments, and beads simultaneously in the appropriate proportions
- A more realistic approach than feeding plastics with no food would be to add MPs to food. Effects are attributed to microplastic intake without consideration of effects from lack of food - starvation

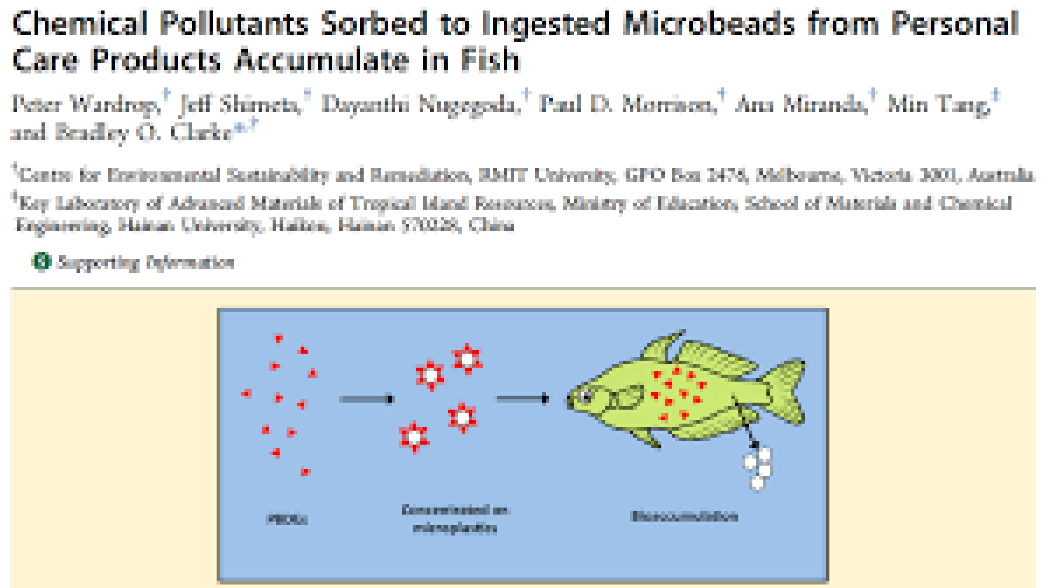
CONTAMINANTS IN AND ATTACHED TO MICROPLASTICS



Are microplastics vectors for transfer of toxicants into animals?

CAN ANIMALS' GUT ENZYMES PULL ADSORBED CHEMICALS OFF THE MICROPLASTICS?





Chemical Pollutants Sorbed to Ingested Microbeads from Personal Care Products Accumulate in Fish

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Supporting Information

How much bioaccumulation compared to that from "real" food?
Much more bioavailable from prey organisms

Desorption half-life from plastic. Some lab studies report complete egestion in 24-48 h. Is plastic in the gut long enough for much desorption?

Available evidence that microplastics act as a vector of organic pollutants into organisms inconclusive. Probably greater bioavailability from contaminated diet.

Maybe MP types that clog up gut and stay there (e.g. fibers) more likely to have more time to desorb chemicals.

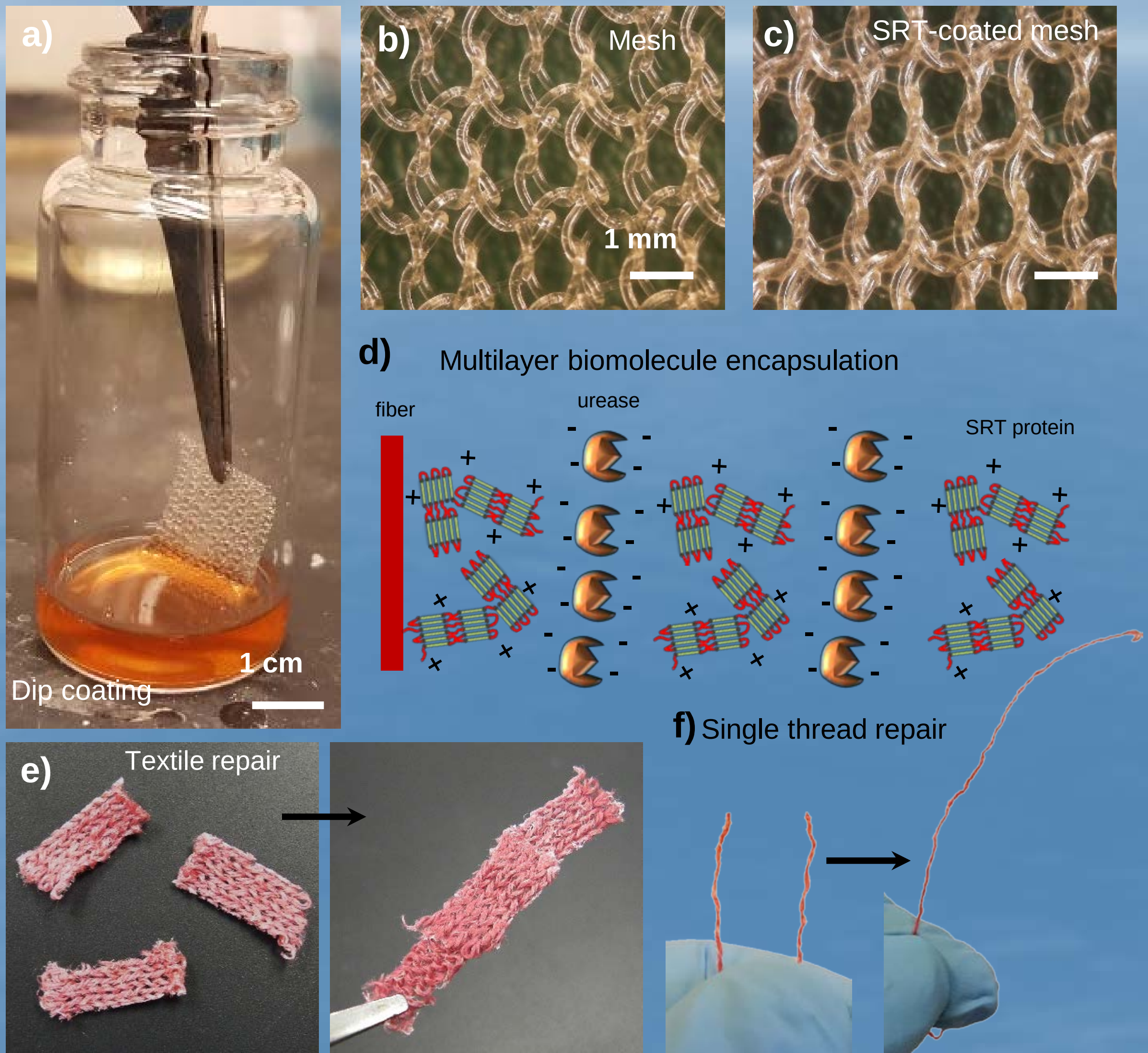
RESEARCH INTO SOLVING THE PROBLEM: WASHING MACHINE MODIFICATIONS

- Lint LuvR filter collects ~90%

- Cora Ball collects <30%

Re-engineer Textiles: Example
Demirel, Penn State: Self-healing Textiles

Coat fabric with protein isolated from squid suckers



Coating with squid sucker protein reduces shedding of microplastics