Microplastics and Microfibres

What is it and what we know

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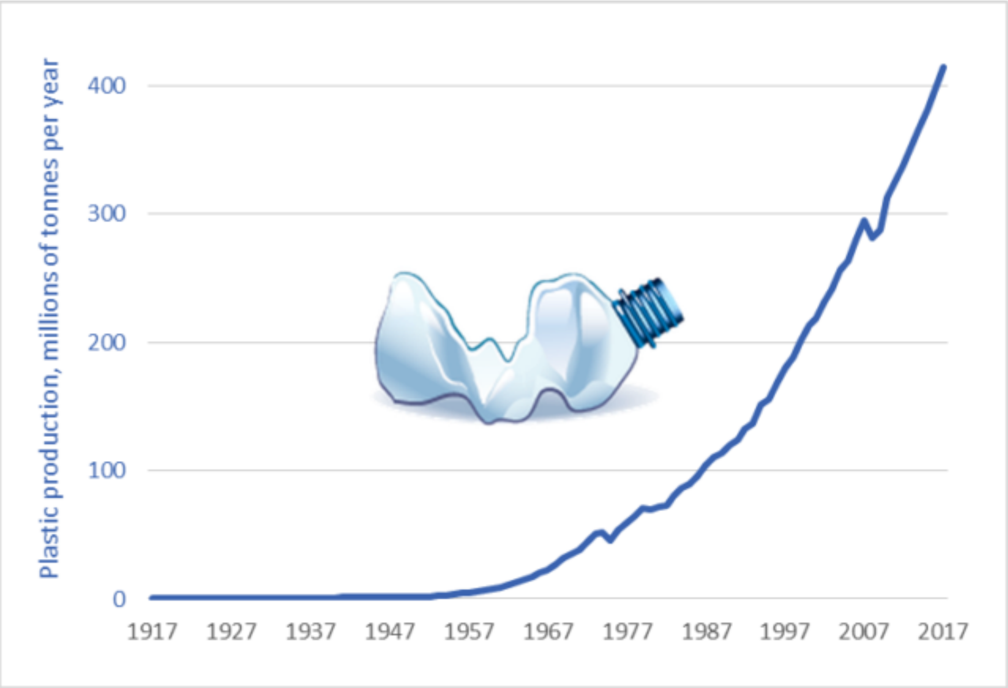
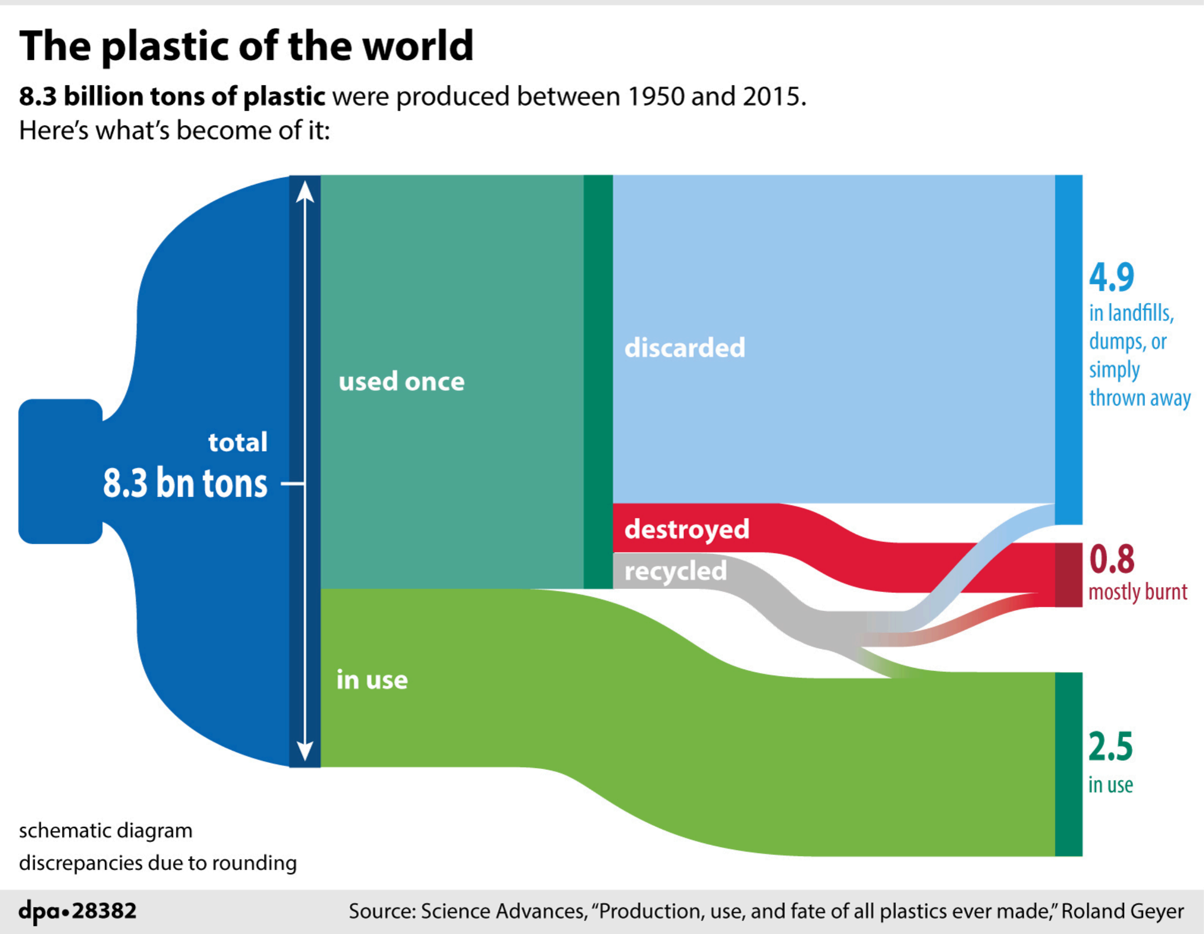
Plastics





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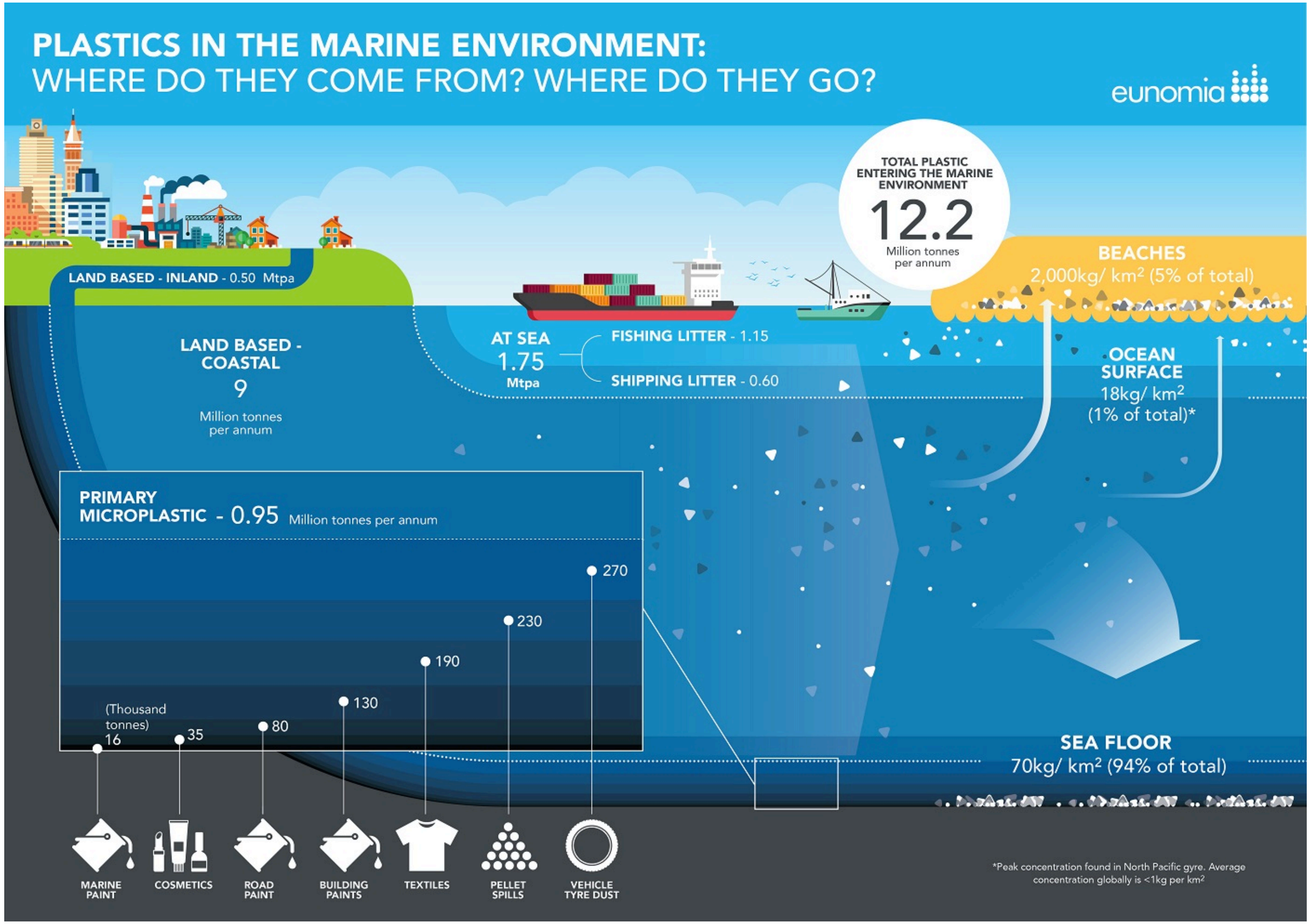
Lost in the environment



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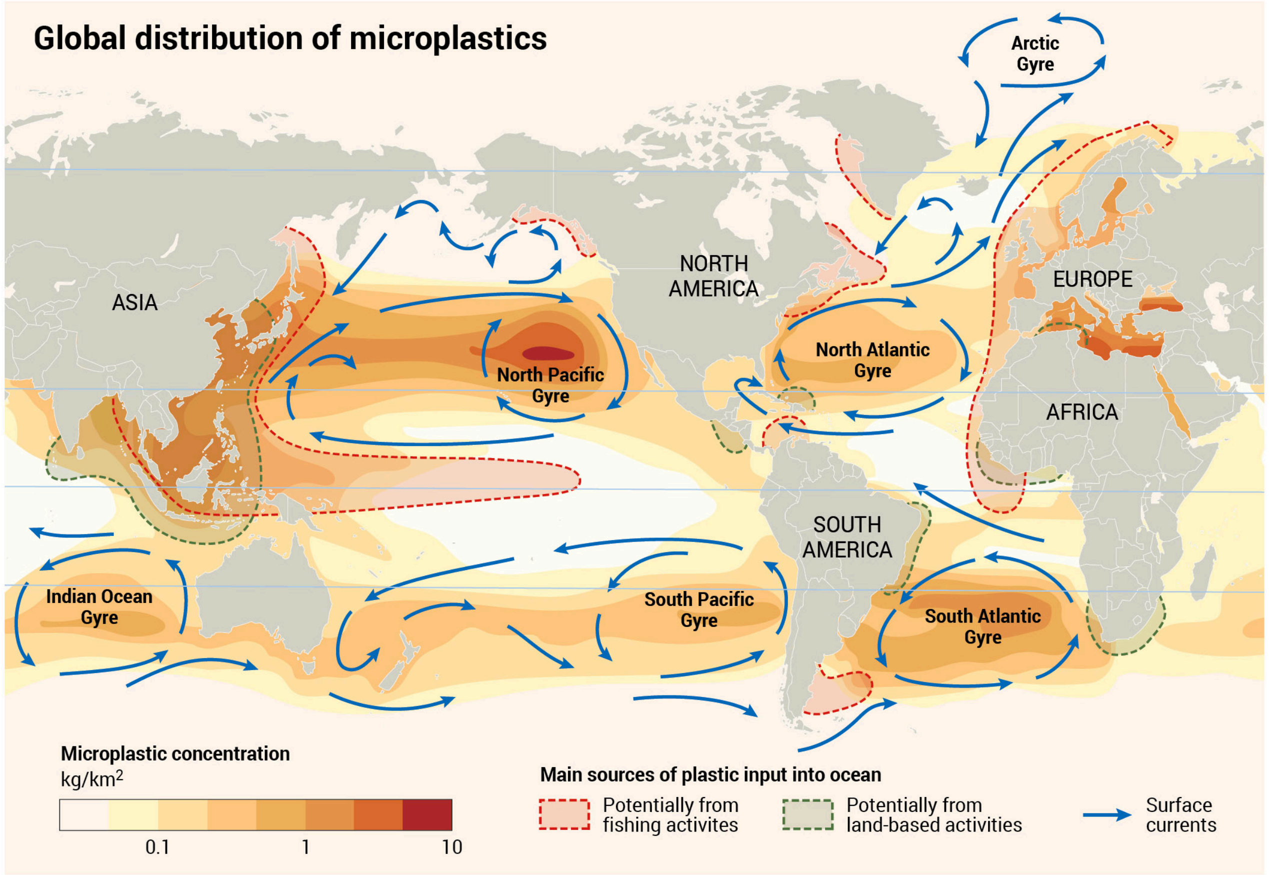
…and found there

- capt. Charles Moore

(North Pacific gyre, 1997)



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(Micro)plastic pollution

…is not new

70s!!

Carpenter, Smith, Science 1972

Colton, Science 1974

Plastic Particles in Surface Waters of the Northwestern Atlantic

The abundance, distribution, source, and significance of various types of plastics are discussed.

John B. Colton, Jr., Frederick D. Knapp, Bruce R. Burns

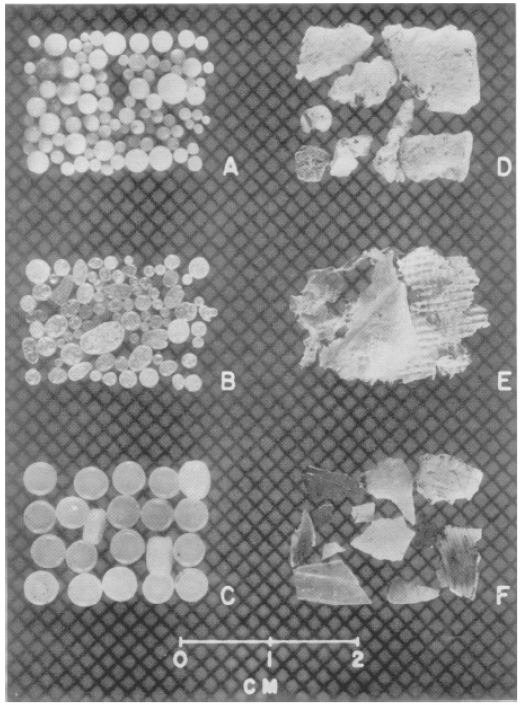

Fig. 2. Typical plastic particles: (A) opaque polystyrene spherules, (B) clear and translucent polystyrene spherules, (C) opaque and translucent polyethylene cylinders, (D) Styrofoam, (E) plastic sheets, and (F) plastic pieces.

Plastics on the Sargasso Sea Surface

Abstract. *Plastic particles, in concentrations averaging 3500 pieces and 290 grams per square kilometer, are widespread in the western Sargasso Sea. Pieces are brittle, apparently due to the weathering of the plasticizers, and many are in a pellet shape about 0.25 to 0.5 centimeters in diameter. The particles are surfaces for the attachment of diatoms and hydroids. Increasing production of plastics, combined with present waste-disposal practices, will undoubtedly lead to increases in the concentration of these particles. Plastics could be a source of some of the polychlorinated biphenyls recently observed in oceanic organisms.*

While sampling the pelagic *Sargassum* community in the western Sargasso Sea, we encountered plastic particles in our neuston (surface) nets. The occurrence of these particles on the sea surface has not yet been noted in the literature [we also collected petroleum lumps, which have received attention (*1*, *2*)].

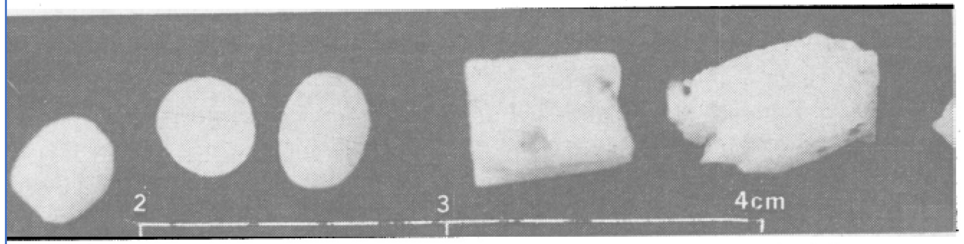

Fig. 1. Typical plastic particles from tow 2. White pellets are on the left.

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Microplastics

- Invention of microplastics

Richard Thompson, Science 2004

("microscopic plastics")

BREVIA

Lost at Sea: Where Is All the Plastic?

Richard C. Thompson,[1]* Ylva Olsen,[1] Richard P. Mitchell,[1] Anthony Davis,[1] Steven J. Rowland,[1] Anthony W. G. John,[2] Daniel McGonigle,[3] Andrea E. Russell[3]

Millions of metric tons of plastic are produced annually. Countless large items of plastic debris are accumulating in marine habitats worldwide and may persist for centuries (*1–4*). Here we show that microscopic plastic fragments and fibers (Fig. 1A) are also widespread in the oceans and have accumulated in the pelagic zone and sedimentary habitats. The fragments appear to have resulted from degradation of larger items. Plastics of this size are ingested by marine organisms, but the environmental consequences of this contamination are still unknown.

Over the past 40 years, large items of plastic debris have frequently been recorded in habitats from the poles to the equator (*1–4*). Smaller fragments, probably also plastic, have been reported (*5*) but have received far less attention. Most plastics are resistant to biodegradation, but will break down gradually through mechanical action (*6*). Many "biodegradable" plastics are composites with materials such as starch that biodegrade, leaving behind numerous, nondegradable, plastic fragments (*6*). Some cleaning agents also contain abrasive plastic fragments (*2*). Hence, there is considerable potential for large-scale accumulation of microscopic plastic debris.

To quantify the abundance of microplastics, we collected sediment from beaches and from estuarine and subtidal sediments around Plymouth, UK (Fig. 1B). Less dense particles were separated by flotation. Those that differed in appearance to natural particulate material (Fig. 1A) were removed and identified with Fourier Transform infrared (FT-IR) spectroscopy (*7*). Some were of natural origin and others could not be identified, but about one third were synthetic polymers (Fig. 1C). These polymers were present in most samples (23 out of 30), but were significantly more abundant in subtidal sediment (Fig. 1D). Nine polymers were conclusively identified: acrylic, alkyd, poly (ethylene:propylene), polyamide (nylon), polyester, polyethylene, polymethylacrylate, polypropylene, and polyvinyl-alcohol. These have a wide range of uses, including clothing, packaging, and rope, suggesting that the fragments resulted from the breakdown of larger items.

To assess the extent of contamination, a further 17 beaches were examined (Fig. 1B). Similar fibers were found, demonstrating that microscopic plastics are common in sedimentary habitats. To assess long-term trends in abundance, we examined plankton samples collected regularly since the 1960s along routes between Aberdeen and the Shetlands (315 km) and from Sule Skerry to Iceland (850 km) (*7*) (Fig. 1B). We found plastic archived among the plankton in samples back to the 1960s, but with a significant increase in abundance over time (Fig. 1E). We found similar types of polymer in the water column as in sediments, suggesting that polymer density was not a major factor influencing distribution.

It was only possible to quantify fragments that differed in appearance from sediment grains or plankton. Some fragments were granular, but most were fibrous, ~20 μm in diameter, and brightly colored. We believe that these probably represent only a small proportion of the microscopic plastic in the environment, and methods are now needed to quantify the full spectrum of material present. The consequences of this contamination are yet to be established. Large plastic items can cause suffocation and entanglement and disrupt digestion in birds, fish, and mammals (*3*). To determine the potential for microscopic plastics to be ingested, we kept amphipods (detritivores), lugworms (deposit feeders), and barnacles (filter feeders) in aquaria with small quantities of microscopic plastics. All three species ingested plastics within a few days (*7*) (fig. S1).

Our findings demonstrate the broad spatial extent and accumulation of this type of contamination. Given the rapid increase in plastic production (Fig. 1E), the longevity of plastic, and the disposable nature of plastic items (*2*, *3*), this contamination is likely to increase. There is the potential for plastics to adsorb, release, and transport chemicals (*3*, *4*). However, it remains to be shown whether toxic substances can pass from plastics to the food chain. More work is needed to establish whether there are any environmental consequences of this debris.

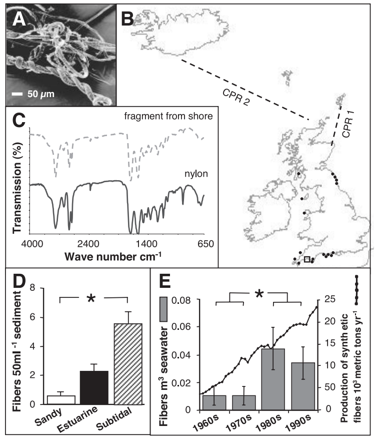

Fig. 1. (**A**) One of numerous fragments found among marine sediments and identified as plastic by FT-IR spectroscopy. (**B**) Sampling locations in the northeast Atlantic. Six sites near Plymouth (□) were used to compare the abundance of microplastic among habitats. Similar fragments (●) were found on other shores. Routes sampled by Continuous Plankton Recorder (CPR 1 and 2) were used to assess changes in microplastic abundance since 1960. (**C**) FT-IR spectra of a microscopic fragment matched that of nylon. (**D**) Microplastics were more abundant in subtidal habitats than on sandy beaches (*, $F_{2,3}$ = 13.26, $P < 0.05$), but abundance was consistent among sites within habitat types. (**E**) Microscopic plastic in CPR samples revealed a significant increase in abundance when samples from the 1960s and 1970s were compared to those from the 1980s and 1990s (*, $F_{3,3}$ = 14.42, $P < 0.05$). Approximate global production of synthetic fibers is overlain for comparison. Microplastics were also less abundant along oceanic route CPR 1 than along CPR 2 ($F_{1,24}$ = 5.18, $P < 0.05$).

References and Notes

1. P. G. Ryan, C. L. Moloney, *Nature* **361**, 23 (1993).
2. M. R. Gregory, P. G. Ryan, in *Marine Debris*, J. M. Coe, D. B. Rogers, Eds. (Springer, Berlin, 1996), pp. 48–70.
3. J. G. B. Derraik, *Mar. Pollut. Bull.* **44**, 842 (2002).
4. E. J. Carpenter, S. J. Anderson, G. R. Harvey, H. P. Miklas, B. P. Bradford, *Science* **178**, 749 (1972).
5. J. B. Colton, F. D. Knapp, B. R. Burns, *Science* **185**, 491 (1974).
6. P. P. Klemchuck, *Polym. Degrad. Stab.* **27**, 183 (1990).
7. Materials and methods are available as supporting material online on *Science* Online.
8. We thank C. Hoare, R. Ticehurst, G. Mandair, and F. Birembaut for help with sample collection and analysis. Supported by the Leverhulme Trust, UK.

Supporting Online Material
www.sciencemag.org/cgi/content/full/304/5672/838/DC1
Materials and Methods
Fig. S1
References and Notes

10 December 2003; accepted 10 February 2004

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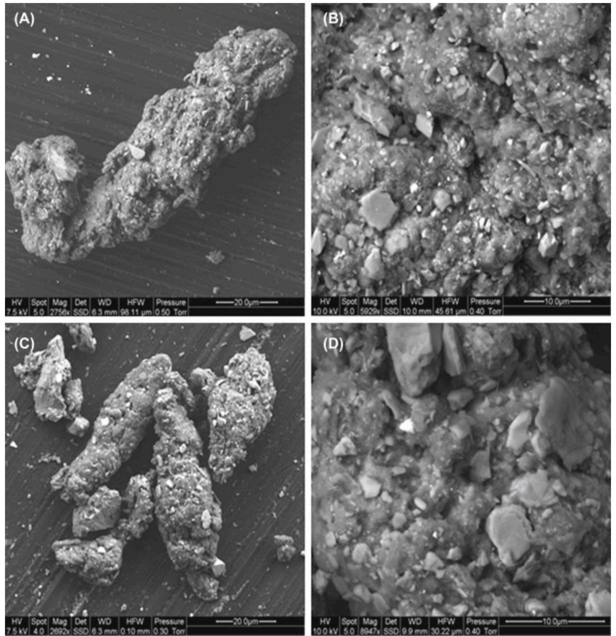
What is it?

- Plastic particles smaller than 5 mm (arbitrary)
- Lower size limit ? 300 μm 333μm now talking about nanoplastics

- Primary microplastics – made that way (plastic pellets, plastics in cosmetics)
- Secondary microplastics – product of fragmentation

- TRWP Tire and Road Wear Particles



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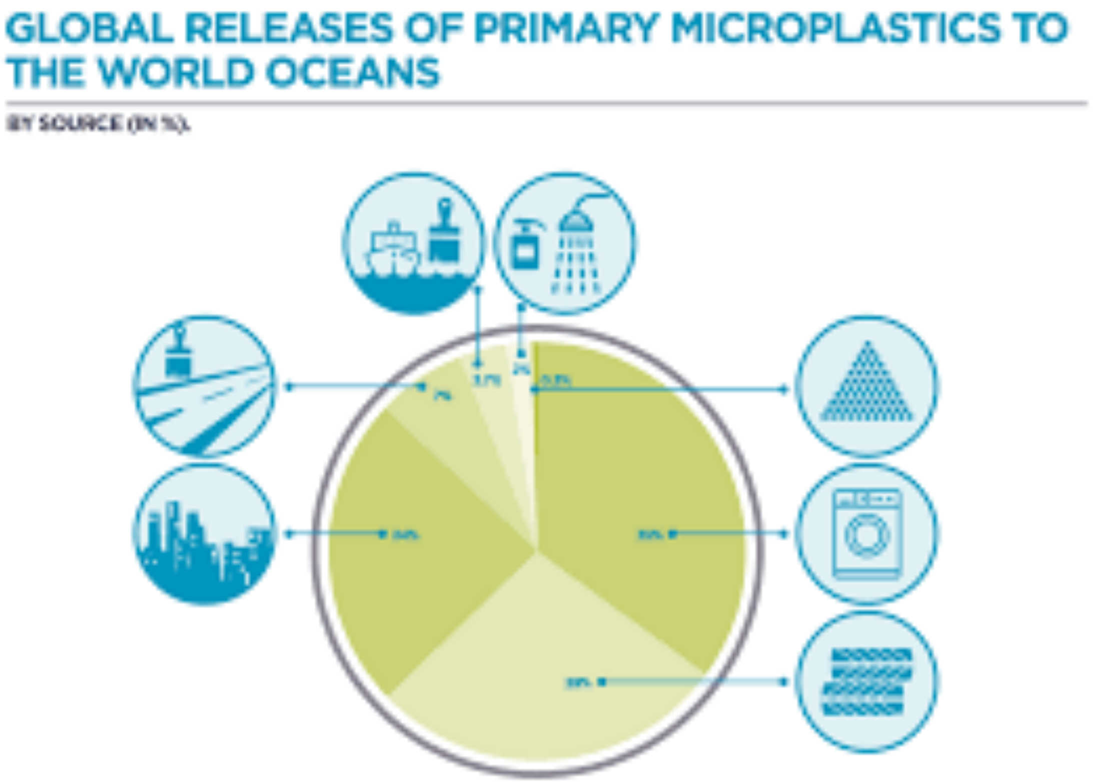
Sources?

By application/product



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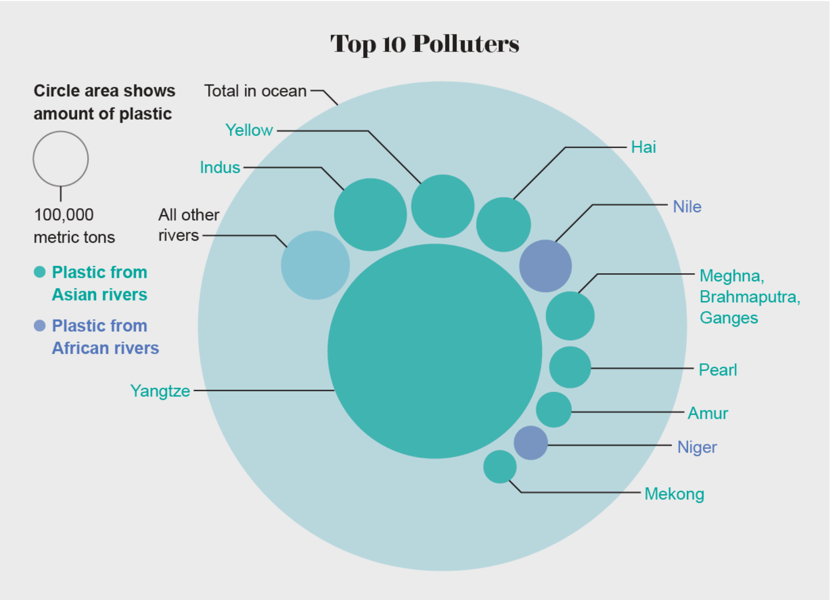
Sources?

By geolocation



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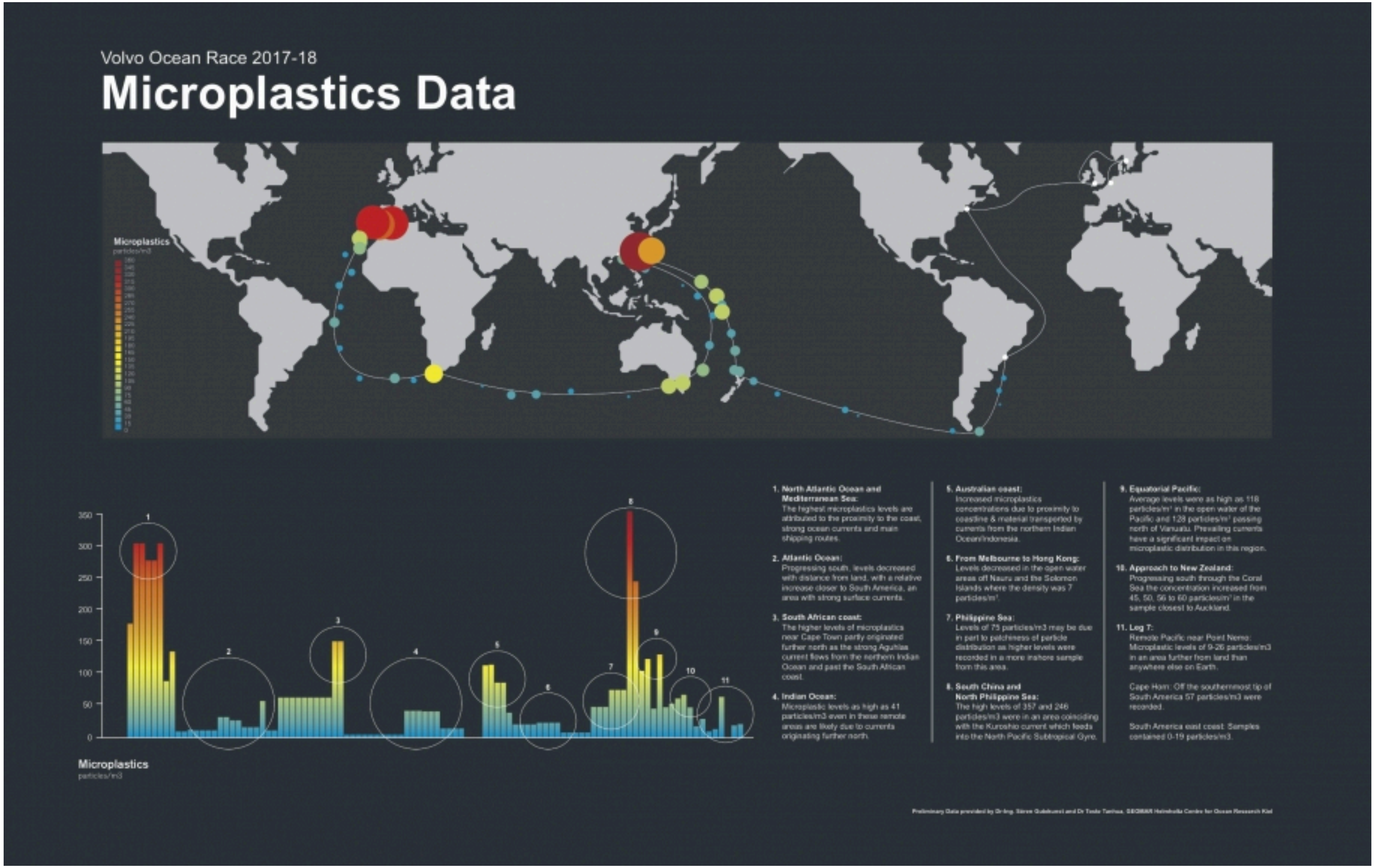
Where?

- **Everywhere**
- Point NEMO
- Arctic
- Marianna
- Trench



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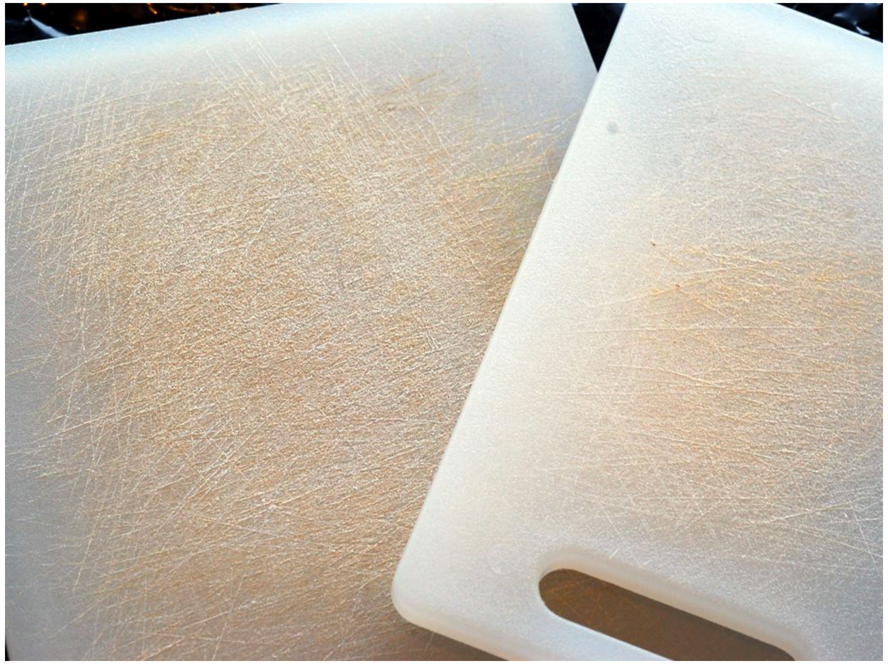
In humans

- Food
- Pollution

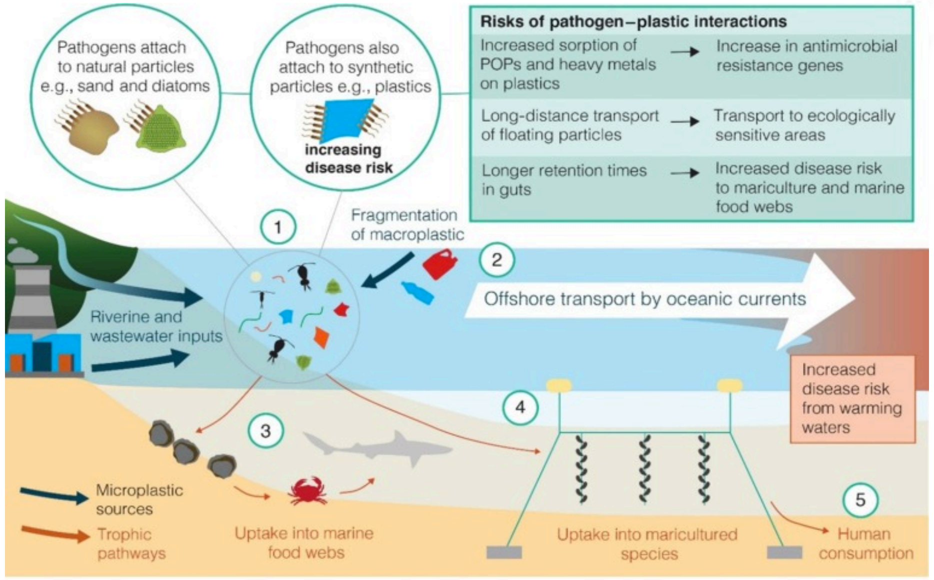
>> body

Lungs, digestive tract, placenta!

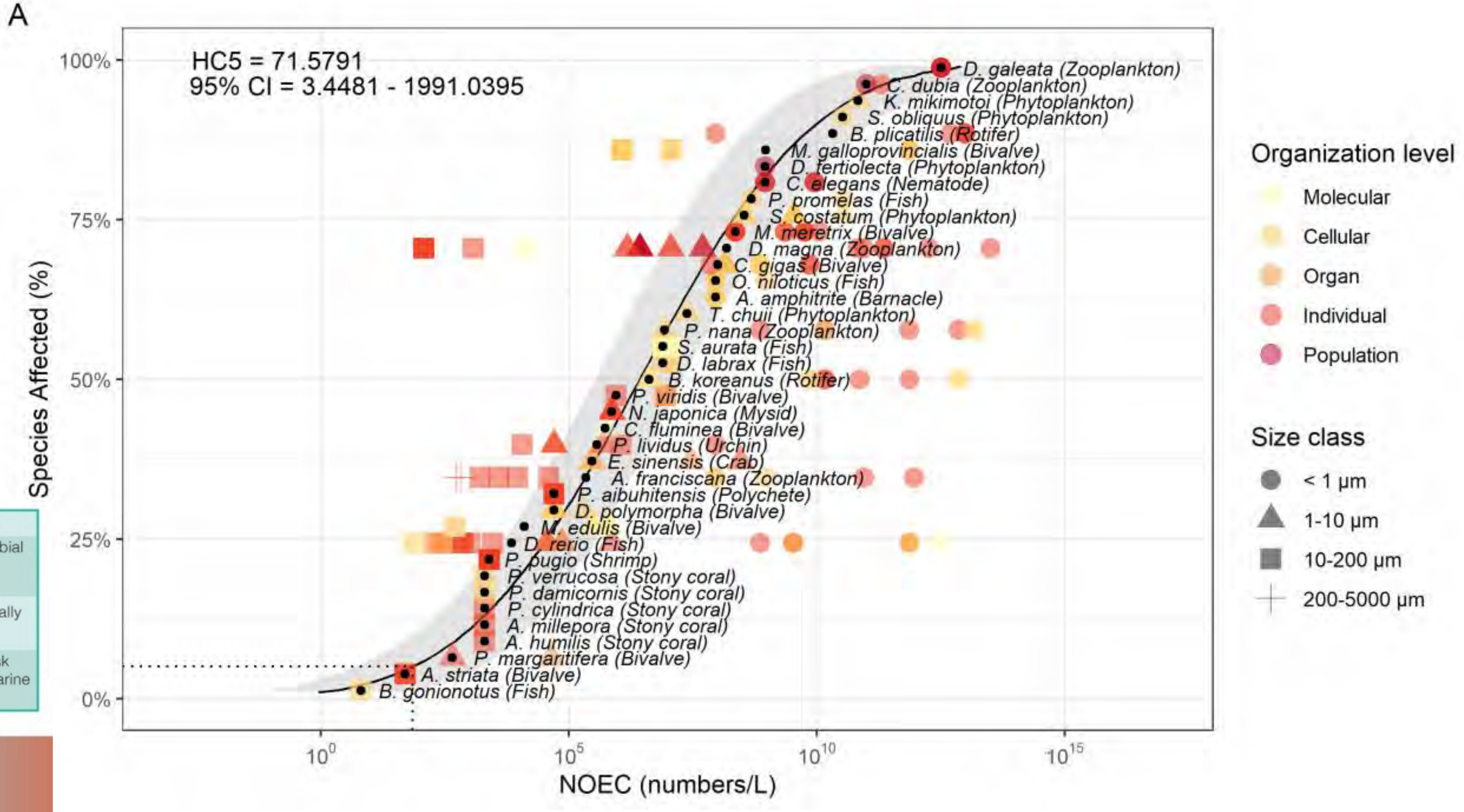


Effects?

- Intense research
- Not positive



Trends in Microbiology



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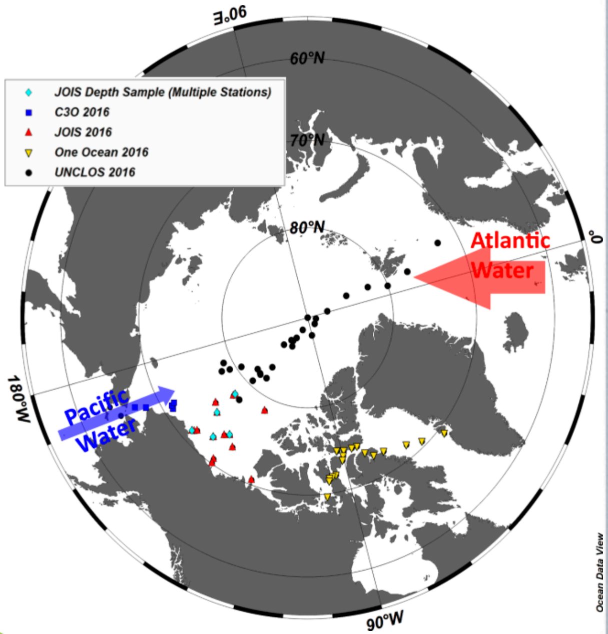
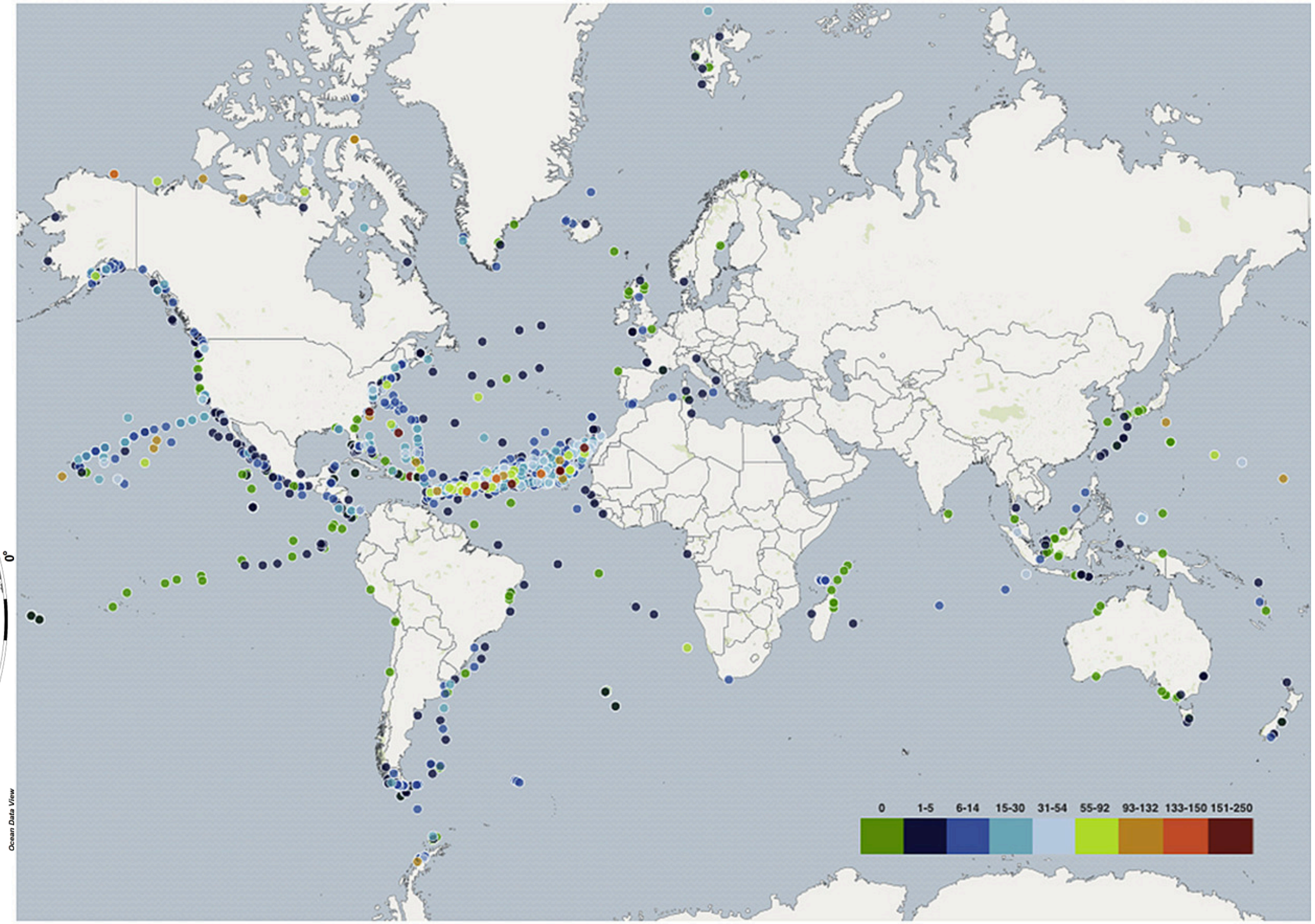
Fibers

- Easy to migrate
- Durable
- Ingestion prone
- Hard to catch





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Fibers

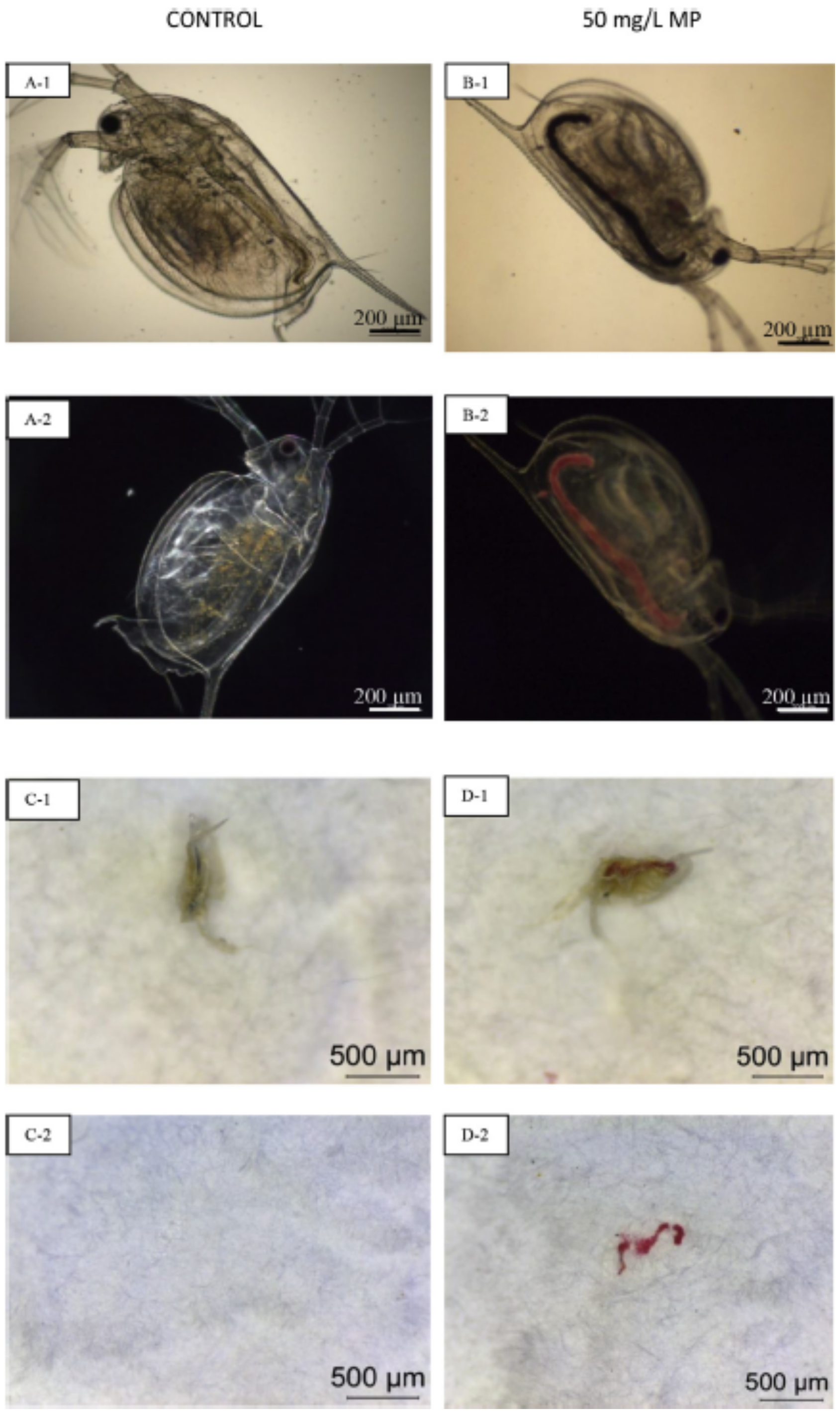
- Shedding depends on conditions:

Textile, load, detergent, T, machine/program, dryi

- Up to 0,25g /kg (0,025 wt%)

- Wide range of lengths 50μm – 5mm+
  >> can be ingested by many organisms
- High specific surface – easy migration

- Synthetic fiber use growing 60+% (blends!)
- Natural fibres not neutral



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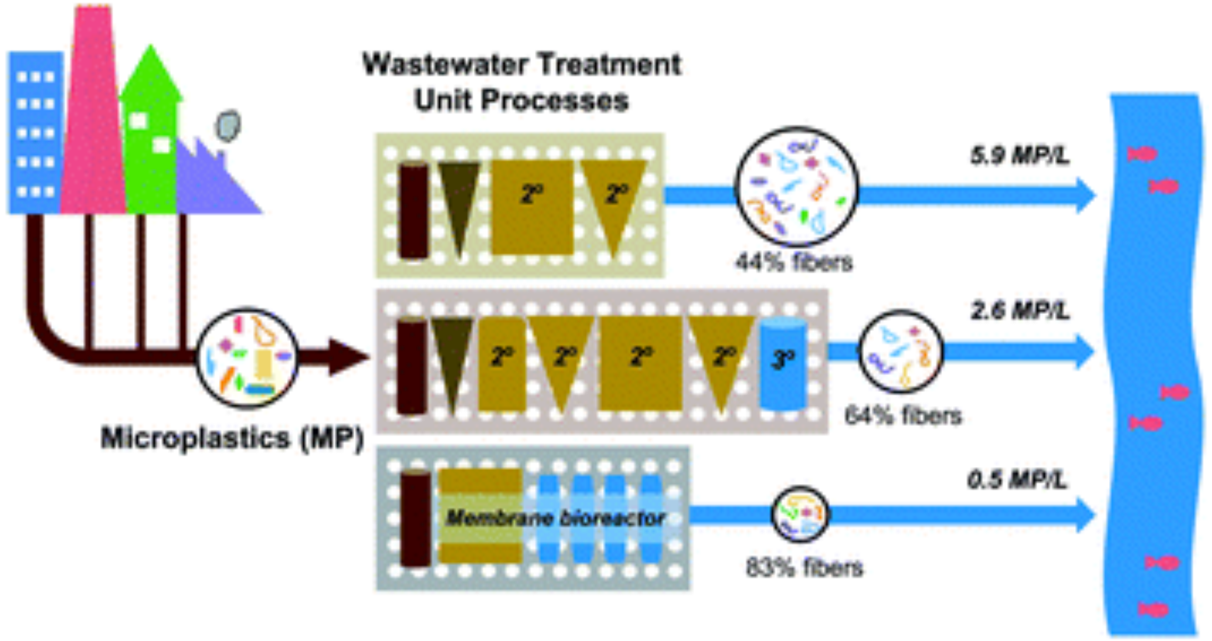
Mitigation of fibre pollution

Three-prong action

- Textile improvements (longer term)
- Filtering at source (fastest, future: washing machines with filters)
- WWTP (investment)

- Legislation appearing
- (France, US, Netherlands, Sweden)



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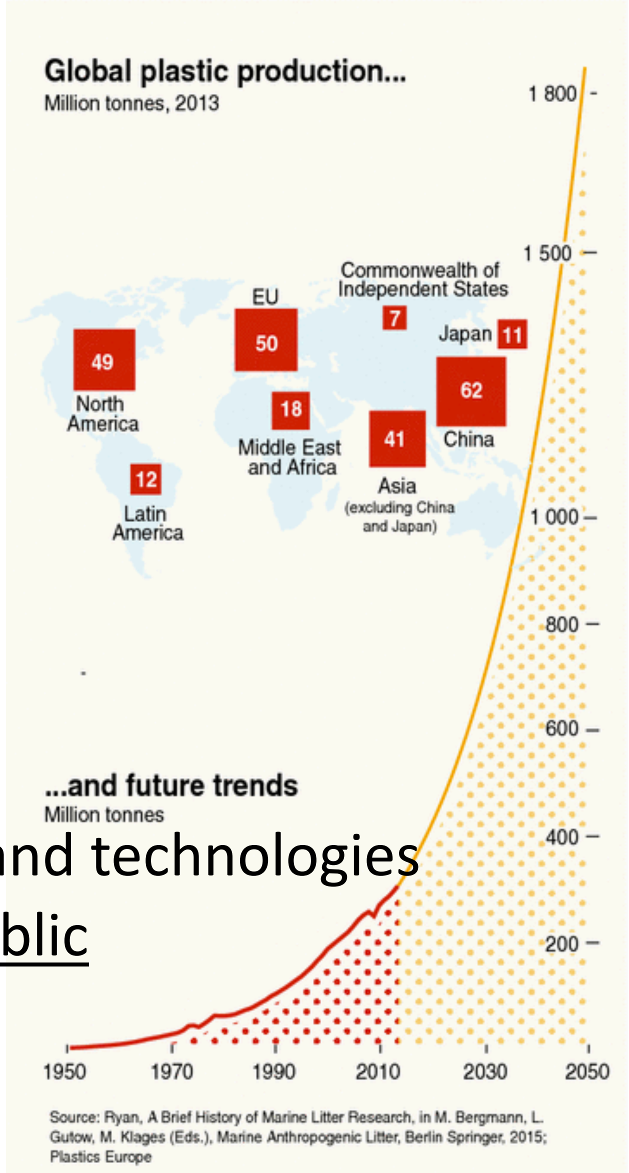
Challenge

- Plastic use will continue to grow
- Microplastics already contaminate our planet
- Microplastics in environment are impossible to collect
- Effects are negative

- Must stop emissions
- Change practices, products, use pollution prevention methods and technologies
- Multistakehoder approach needed: science, R&D, NGO, Gov, <u>public</u>
- International effort
- Similar to climate change: NO TIME TO LOSE
- Not only challenge & hazard!



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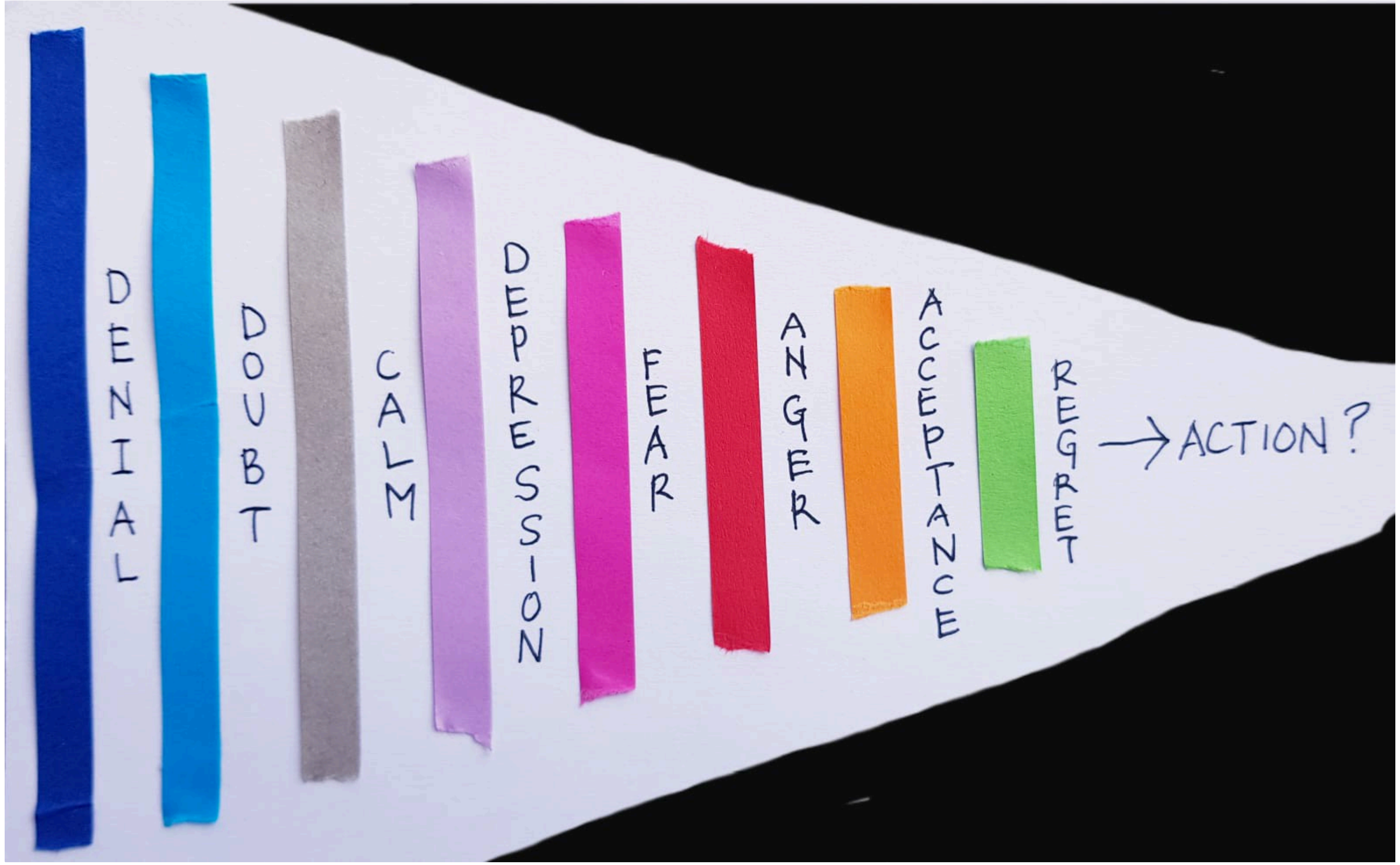
We know



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-Mojca Zupan, founder & CEO

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Life-changing Exhibition

Each one of us throws **one light plastic grocery bag worth of microplastics into the ocean every week** simply by washing our clothes.

PlanetCare: founded 2017

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Efficient & Accessible

The first and only washing machine filter with **proven efficiency to stop 90% of microfibers.** Available worldwide.

Closed loop service

Catching microfibers is only the first step. With our unique return & reuse service we make sure all used cartridges are refurbished: **95% is reused, and 5% recycled.**

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Independently Tested

“PlanetCare is the best microfiber filtering solution on the market.”

- Swedish Environmental Protection Agency, Dec 2020

A wide range of quality solutions

Development of filter variants to **cover all washing machine types** (domestic, commercial, industrial)

Partnership network

NGOs, national policy makers and other relevant stakeholders (OECD, UN, fashion & textile industry,...)

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Policy Change

PlanetCare is an **active stakeholder in governmental groups** across Europe (France, Sweden, the Netherlands), which is resulting in policy changes and has direct effects on the washing machine industry.

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"

Finally consumers can take action. If we wait for the fashion industry, it can take years before the problem is solved.

- Maria Westerbos, Founder at Plastic Soup Foundation

PlanetCare has been featured in

CNN Bloomberg Green FAST COMPANY

Treehugger Daily Mail

goop POOSH

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Reduce microfiber pollution

- Choose clothes from natural fibers
- Take good care of your clothes, mend them, and buy new less often
- Wash full loads, at lower temperatures, and only when really necessary
- Dispose of dryer lint properly
- Use a microfiber filter

Never doubt that a small group of thoughtful, committed, citizens can change the world. Indeed, it is the only thing that ever has.

- Margaret Mead

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