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GUEST EDITORIAL

# How about nano? Impact of size of plastics on plastic pollution and the magnitude of the problem

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## INTRODUCTION

In the last decade we have realized that the plastics we use every day, and for practically everything, may be the biggest environmental polluters humans have ever released to the environment (EU DG, 2011). Since the first reports of plastic pollutions, we have learned so much about the issue. Macro and micro plastic pollution topics have been extensively studied, investigated, regulated, and in some cases litigated (Uren Webster et al., 2020)(Barnes, Galgani, Thompson, & Barlaz, 2009)(Environment Agency, 2018). As it happened in most of the past cases, we have started with the most obvious and visible problem: macro plastics.

**Macro plastics:** It is very easy to detect a macro plastic pollution, because of their sizes, and it is relatively easy to remove them from the environment. How hard it is to pick up plastic bottles from the beach or collect disposed masks from the side of a road? The impact of macro plastics is also limited to physical ones. Sharp plastics hurting internal organs of the marine animals or wrapped plastics slowly choking sea turtles are some of the most common examples we can see in the nature. However, because majority of the common plastics are non-toxic and not chemically active, there have been no (or very little) evidence that macro plastics have toxic impact on the environment (Barnes et al., 2009).

The importance of the topic and severity of the scale of the global plastic pollution led researchers to look at smaller plastic particles, especially the ones which are small enough to escape traditional detection: micro plastics.

**Micro plastics:** Microplastics are often described as plastics with size smaller than 5 mm (Sullivan et al., 2020a), and they are much harder to detect compared to macro plastics. In the past decade, researchers developed many techniques to detect and characterize micro plastics. One of the most common methods is to use a plankton net and visually confirm/count the plastics (in water sources) trapped in the net (EU DG, 2011). However, this method cannot tell us what type of plastic is in the water. The solution to this problem was to use thermal degradation combined with gas chromatography, and pyrolizer-GC-MS was found to be one of the most powerful analytical methods to identify plastics found in water sources. (Sullivan et al., 2020b). There were also number of research projects looking at the introduction of micro plastics in food chain and the impact of them to animal and/or human health. Even though the evidence of microplastics in digestive tracks of aquatic animals and humans were found, the direct impact of microplastics was never proven. The main reason behind this is the size of the plastics. As it is well known that most plastics are resistant to mild oxidation and chemically inactive chemicals (inert), therefore they can pass through the digestive tracks without any changes and can be easily excreted.

However, this changes when the particle, inert or not, is smaller than 100nm (Delgado-Gallardo et al., 2022). In the last 7-8 years we have seen evidence that nanoparticles (smaller than 100nm in size) can have a detrimental impact on the animal and human health. Any particle smaller than 100nm in size can potentially penetrate the cell of a living organism. For example, silicon oxide particles can cause cell death and can start cancerogenic formations in the cell they penetrated into (Delgado-Gallardo et al., 2022).

## NANOPLASTICS

When I first started working on plastic pollution topic in 2017, the only question in my mind was 'What if there are nanoplastics in the nature but we cannot detect them?'. I started working on a method which can enable me to detect nanoplastics in water. After months of study and investigation, the solution I have found was:

- Filter the water (with plastics in it) with a nanofiltration membrane (pore size < 100nm)
- All the particles bigger than 100nm will be deposited on the membrane

- Laser cut the membrane to small pieces, which can be fed into pyrolizer tubes
- Pyrolyze the membrane with plastics and pass it through GC-MS
- Separate plastic peaks from membrane material peaks
- Identify the type of plastics

We have tested this method with model solutions (plastic dosed DI water) and validated it with actual river water (Tawe River, UK) (Sullivan et al., 2020b). The results were astonishing, we have detected Polystyrene in River Tawe, which was not detected with common microplastic detection methods. In addition to this, we have also semi quantified polystyrene by using analytical data.

What happened after was something no one was expecting: Covid 19. We had to change our approach and focus on Covid 19 and its impact on environment. We have decided to look at the durability and fate of disposable plastic masks in environment (Sullivan, Delgado-Gallardo, Watson, & Sarp, 2021). During Covid era, we have seen disposable plastics masks being littered, thrown away, and piled on landfills. Our main focus was the amount of nanoplastics released from these masks when these masks exposed to water (rain, runoff, ocean, etc.). Our study showed that, each one of these masks' releases at least 1000s of micro and nano particles to environment, and most of these cannot be detected with common methods. We have also proved that these masks emits nano silicon particles and heavy metals as well, including Arsenic and lead (Delgado-Gallardo et al., 2022; Sullivan et al., 2021).

## CONCLUSION

Plastic problem is much bigger than we currently understand. The magnitude of the problem is coming from the size of the plastics in the environment. We are being exposed to nanoparticles from textile products, car tires, cosmetic products, and even personal protection equipment (masks etc.). There is a lot of research to be done and a lot of regulations to be implemented by governments.

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